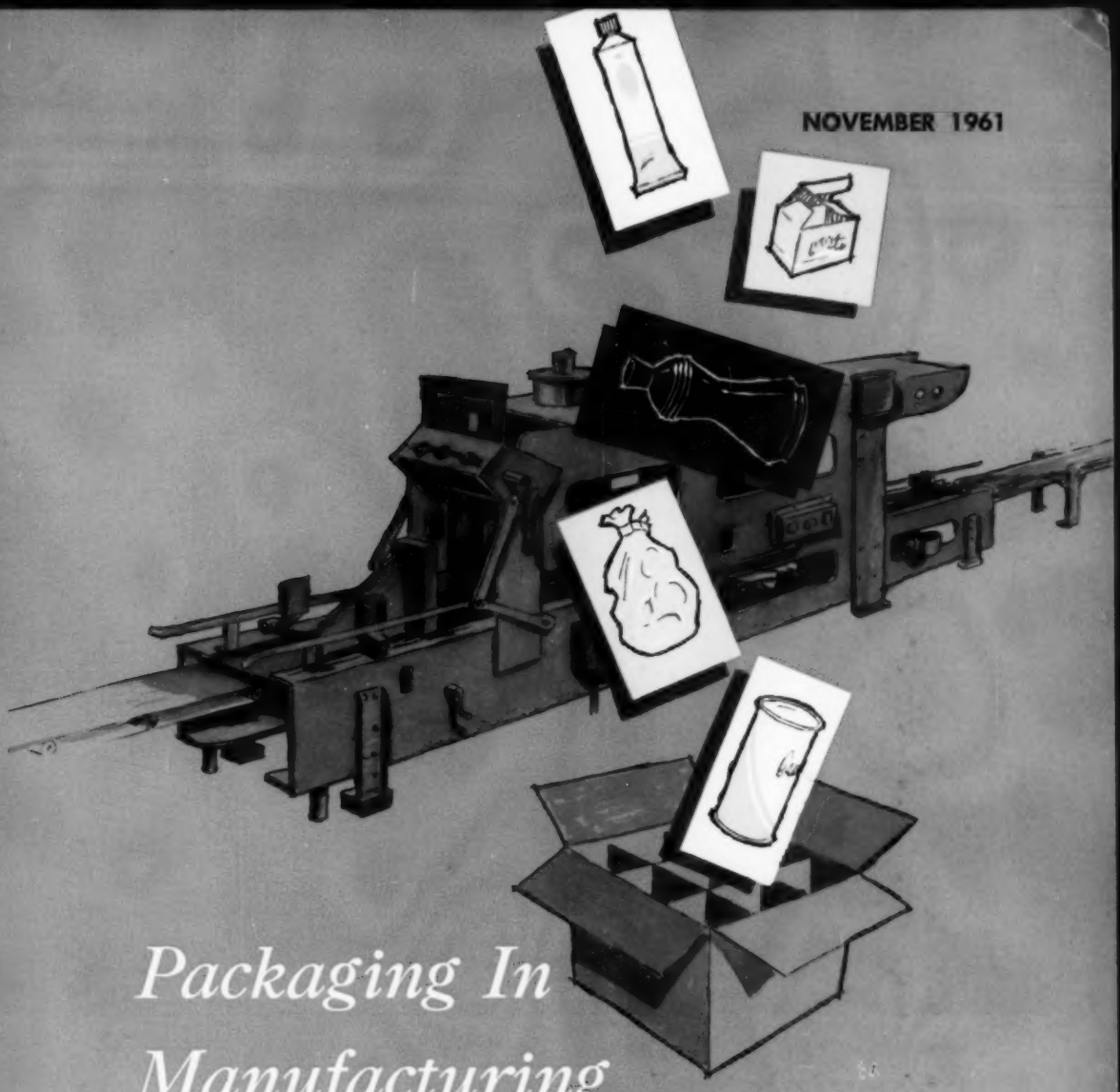
AUTOMATION

NOVEMBER 1961



Packaging In Manufacturing

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- **Making Incandescent Lamps**
- **Circuit Cards Tested Automatically**
- **Monitoring, Logging, and Control with Data**
- **Systems to Control Time Cycles**

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A PENTON PUBLICATION

Ernst cuts steel costs to customers up to 10% with three new Wean Coil Processing Lines

During a recent call on Ernst Iron Works, Division of Ernst Steel Corporation, Jim Moon, sales engineer of McKay Machine (above left), talked with Carl Grosse, plant superintendent, about the three Wean coil processing lines recently installed by this major metals warehousing firm.

According to Mr. Grosse, the Wean slitting, shearing and coil banding lines have reduced Ernst's handling, labor and scrap costs up to 10%. In addition to providing lower costs to Ernst's customers, this modern coil processing system helps this firm give fast service while easing inventory and supply problems through the purchase of standard size coils.

Equipped with modern, automatic controls, the Wean coil processing lines are operated by only four men and can handle 20,000 lb. coils, up to 54" wide and from .015" to .135" thick.

The McKay Machine Company, Youngstown 1, Ohio

The McKay Machine Company is licensed to manufacture, sell and service metal processing machinery formerly manufactured by Wean Equipment Corporation, Cleveland, Ohio.

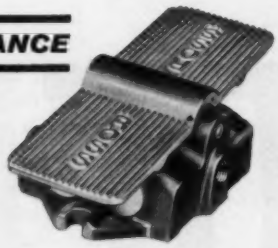
McKAY McK MACHINE

Circle 651 on Reply Card

The world's largest line of air valves is also the most advanced because of the Ross engineering staff

Do you know these Ross air controls?

EASY MAINTENANCE



Rugged, dependable foot valve

The 600 valve series. Features maintenance without disconnecting piping, rugged construction and a variety of treadle options: double or single treadle; spring return or detent. Also available as a hand valve. 3-Way and 4-Way models, ¼".

AIR AUTOMATION

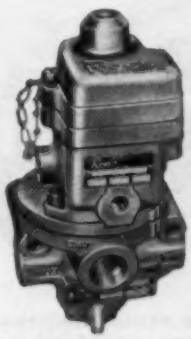
Time delay sequencing valves

The Ross Graymodel Valve is actuated by pilot air from another part of the circuit. Times in with cartridge in one position, times out if cartridge is reversed. Adjustable to 0 to 3 second delay.

RUGGED

More Comfort for Machine Operator

Push buttons may lead to sore fingers but not this palm button valve. 2⅛" button is comfortably convex. Valve is ruggedly built, available with or without key-locking feature. Red or green button, flange mounting. S-Way or 3-Way.



ECONOMY

Small valve does bigger valves work

The Pacer Headline Valve gives you highest capacity valve-size for valve-size of any solenoid valve on the market. Capable of rapid cycling, consumes little power. S-Way, 3-Way and 4-Way models. ¼" through 1½" pipe sizes.

For more information write us, or contact your nearby Ross representative. See our digest catalog in Sweet's

THE WORLD'S MOST COMPLETE LINE OF AIR CONTROL VALVES. AVAILABLE ALL OVER THE FREE WORLD.

ROSS OPERATING VALVE COMPANY

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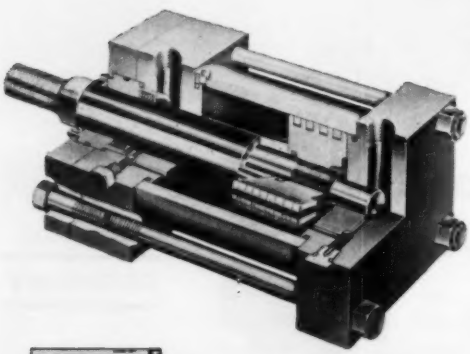
complete new line of
rugged, compact hydraulic...

CYLINDERS



NEW DENISON HYDRAULIC CYLINDER LINE *includes units for pressures from 1000 to 5000 psi, bore sizes from 1⅛" to 14", 17 different mountings. Write for free literature.*

HYDRAULIC CYLINDERS—combining the same high standards of quality as well-known Denison hydraulic pumps, motors, valves, controls—are now available in a complete line of standard sizes for a wide range of applications. Denison hydraulic cylinders are carefully designed for rugged service, long life and easy maintenance with these outstanding features for reliability and economical performance—

Tapered cushion piston provides gradual, shock-free deceleration. No need for cushion adjusting screws.

Chrome plated, high tensile steel piston rod has hard, smooth surface and high corrosion resistance.

Teflon rod wiper keeps rod clean and free of abrasive dirt and dust.

Multi-lip rod packing assures low friction and long life. Self-adjusting to pressure and wear.

Fine grain alloy cast iron piston is precision fit, threaded and pinned to rod.

Cartridge type bronze bushing for maximum wear resistance. Simple to change with only a wrench.

Micro-finished steel cylinder tube with extrusion-proof seals at both ends.

Contact your nearby Denison hydraulic field specialist for full details.

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American Brake Shoe Company
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PUMPS • MOTORS • CONTROLS

DENISON
HYDRAULIC POWER

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The Magazine of Automatic Manufacturing Operations

NOVEMBER 1961
Vol. 8—No. 11

AUTOMATION

A PENTON PUBLICATION

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around the triangle

INDIRECT STIRRING FOR MOLTEN STEEL

Induction system for mixing molten steel in electric arc furnaces of 30 to 200 tons has been developed by Westinghouse Electric Corp. The stirring system works on the principle of passing magnetic fields through the melt to produce a stirring action. When the magnetic field generated is swept through the molten bath of steel, it produces a series of eddy currents. The eddy currents in turn react with the magnetic field of the stirrer to move the steel and achieve a required uniformity in the melt. The entire system is mounted directly under the furnace and includes a forced-air system to provide adequate cooling.

THIN FILM PRODUCTION SYSTEM TO BE DEVELOPED

A high volume production system for the continuous manufacture of ultra-reliable thin film subassemblies will be developed for the U. S. Navy by the Federal Systems Div., International Business Machines Corp. Technical guidance will be given by the Naval Avionics Facility, Indianapolis (NAFI), as part of the Bureau of Naval Weapons industrial readiness program. The equipment will be used by NAFI to produce thin film devices for experimental electronic systems such as satellite electronic systems, communications devices, and computing equipment.

BLEACHED FIBER STRENGTHENS PUMP PACKING

New TFE-fluorocarbon fiber to be used for braided packing for pumps and valves has been developed by E. I. Du Pont De Nemours & Co. Prior to braiding all carbon is removed from the fiber by bleaching and preshrinking the fiber at 580F for 32 hours. Tests show that this material is less sensitive to the effects of operational and frictional heat, and more receptive to gland adjustment than previous materials. By removing the carbon, the source of exothermic heat is eliminated and the tendency of the packing to burn is reduced. Preshrinking of the yarn before braiding provides a demensional stability when used at elevated temperatures.

SUPERCONDUCTING MAGNET SMALL BUT POWERFUL

A superconducting magnet, the size of a doughnut and weighing only a pound can create a magnetic field twice as strong as that from a conventional magnet weighing 40,000 pounds. The new magnet, developed by Westinghouse Research Laboratories, runs from an ordinary automobile storage battery. A magnetic strength or flux density of 43,000 gauss (43,000 lines per square centimeter) is produced by the magnet. Special techniques had to be developed to prepare the 10-mil wire of niobium-zirconium base superconducting alloy. About 5000 turns are wound into a coil which is immersed in a vessel of liquid helium that keeps it near −450F.

3,000,000TH PATENT BASIC TO MICR

Patent number 3,000,000 was issued by the Patent Office to cover an electronic device important in magnetic ink character recognition (MICR) systems. The patent was issued to Dr. Kenneth R. Eldredge on the basis of a project sponsored at Stanford Research Institute by the Bank of America. Invention has been assigned to General Electric Co. and will be used in computer systems installed or planned for installation at some 50 major banks for processing checking accounts at electronic speeds. A special type font used with the invention was adopted by the American Bankers Association as the common machine language for bank check-accounting. The fonts or symbols are imprinted in magnetic ink along the bottom of conventional bank checks and when they are processed through the equipment, they are read at a rate of 72,000 characters per minute. All the steps in the system are performed in as little as 32-millionths of a second.

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BPA NBP

...Fluid Power news

OILGEAR 40 Years of Fluid Power

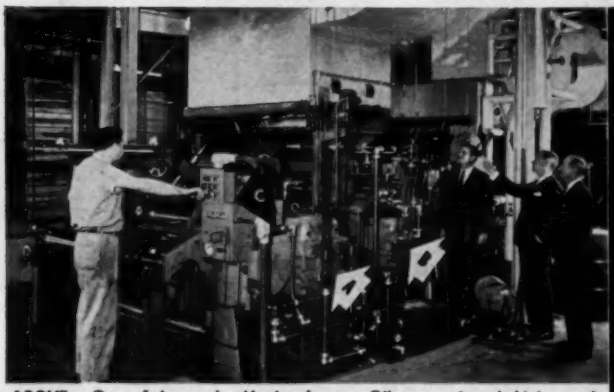
Report No. 11,806 From Oilgear *Application-Engineering* Files

HOW OILGEAR HEAVY-DUTY *Any-Speed HYTAC** DRIVE SYSTEMS ON *Anaconda's* NEW FOIL LAMINATING AND COATING MACHINES HELP SPEED PRODUCTION—CUT COSTS

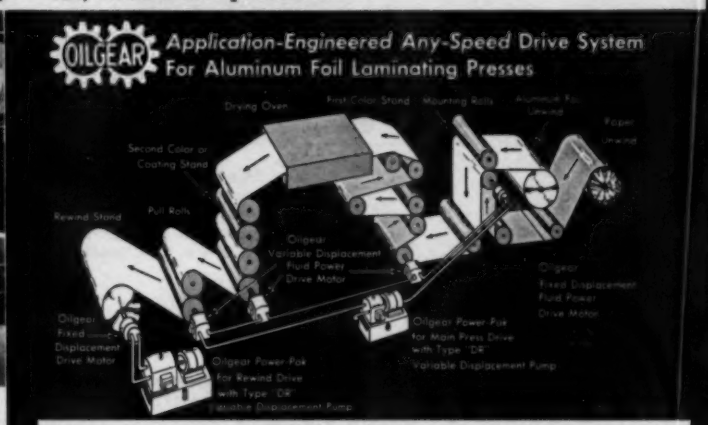
USER: *The Anaconda Aluminum Company, Louisville, Kentucky, Fair Lawn, New Jersey, Terre Haute, Indiana*
(Machine Builder — New Era Manufacturing Company, Hawthorne, New Jersey — successor to Meisel Press Manufacturing Company, Boston, Mass.)

PROBLEM: Main and Rewind Drive Systems for two, new, high-speed laminators to bond aluminum foil as thin as 0.0002" to paper stock ranging from 15-lb tissue to 0.020" carton and food board. In addition to laminating, these "presses" must simultaneously coat and/or color the foil.

REQUIREMENTS: 1. Accurate, wide range, dependable tension control to accommodate *Anaconda's* complete range of laminating foils and paper stock. 2. Infinitely variable, stepless speed range from 0 to 1000 fpm—capable of an optimum, continuous 850 fpm running speed. 3. Maintain tension accurately in "stall" condition indefinitely without overheating—and then pick up speed smoothly and quickly without snapping the sometimes fragile web. 4. Reduce costs through reduction of scrap, repair parts inventories, and machine downtime . . . operate at nearly three times former production speeds. 5. Must be: compact, to conserve valuable floor space; economical on electric power input; capable of continuous, three-shift operation.



ABOVE: One of Anaconda Aluminum's new, Oilgear-equipped, high-speed foil laminating and coating presses—rewind end—as installed at their Louisville, Kentucky, Laminating Plant. Roll cores—8¾" dia. . . . web width—from 23" to 52" . . . roll diameters—to 60" . . . roll weights—to 4500-lb. Tension range—from ½-lb/in. to 4-lb/in. depending on weight of lamination being processed. Arrows (A), (B)—Oilgear Variable Displacement Drive Pumps. Arrow (C)—one of two pushbutton control stations at opposite ends of the press—3 emergency "stop" buttons are located at other positions.


OILGEAR
Application-Engineered Any-Speed Drive System
For Aluminum Foil Laminating Presses
Drying Oven
First Color Stand
Mounting Rolls
Aluminum Foil Unwind
Paper Unwind
Second Color or Coating Stand
Rewind Stand
Pull Rolls
Oilgear Variable Displacement Fluid Power Drive Motor
Oilgear Fixed Displacement Fluid Power Drive Motor
Oilgear Fixed Displacement Drive Motor
Oilgear Power Pak for Rewind Drive with Type "DR" Variable Displacement Pump
Oilgear Power Pak for Main Press Drive with Type "DR" Variable Displacement Pump

Oilgear's patented *Any-Speed HYTAC** Drives (details not shown above) hold any preselected speed within ±0.1% under constant torque loads—within ±0.5% regardless of load, electric power variations, or temperature and viscosity changes . . . provide cushioned starting, remote jogging and threading . . . smooth, even let-off or build-up tensions . . . constant torque . . . adjustable tension . . . hydrodynamic braking. Applied to center shaft winders, *Any-Speed HYTAC** Drives automatically sense and compensate for changes in overall machine speed, and can automatically provide constant, adjustable, or tapering tension over a 20:1 winding range without dancer or follower rolls.

*HYTAC—A registered Oilgear Trademark

SOLUTION: Oilgear *Any-Speed HYTAC** Main and Rewind Drive and Tension Control Systems—as symbolized in the schematic sketch—above right. These compact, heavy-duty systems have successfully met or exceeded all originally specified requirements in continuous, three-shift, high-speed operation. Oilgear Drives were selected for these new machines because of: 1. The enviable record of maintenance-free long-life in several Anaconda Aluminum Plants. For example—six out of seven original, 300-fpm laminating presses at Louisville are Oilgear-equipped . . . two operating continuously since 1946. These 14-year-old drives—and two others—*have NEVER required maintenance other than oil changes and an occasional drive shaft seal.* The other two Oilgear Drives—installed in 1948—were disassembled three years ago merely for a preventive maintenance check—haven't been "touched" since. 2. Oilgear's accurate, dependable tension and speed control over a wide range—for smooth, precise, trouble-free operation on Anaconda's *entire range* of laminating stocks. 3. Space saving—Oilgear Drives occupy less floor space . . . do not require high-speed blowers for cooling—can hold stall-speed indefinitely without overheating. 4. Economy—in electrical power input, maintenance, virtually eliminate costly machine downtime and spare parts inventories . . . and in many cases—at lower installed cost.

Unbelievable?—Not to Oilgear Users! There are case histories upon case histories on file of machines equipped with *Application-Engineered Oilgear Drive Systems* that are rolling along—efficiently, quietly—with over 20 years of trouble- and maintenance-free service! Some additional *installation-proved* reasons . . . the greater accuracy, precision control of speeds, torques, tensions . . . new economies of operation, installation, and valuable floor space . . . are why more and more Oilgear users in the paper, printing and converting, food and beverage, marine, chemical, pharmaceutical, primary metals, metalworking, textile, rubber, military, and other industries all agree that . . .

for the lowest cost per year . . . It's OILGEAR!

For practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

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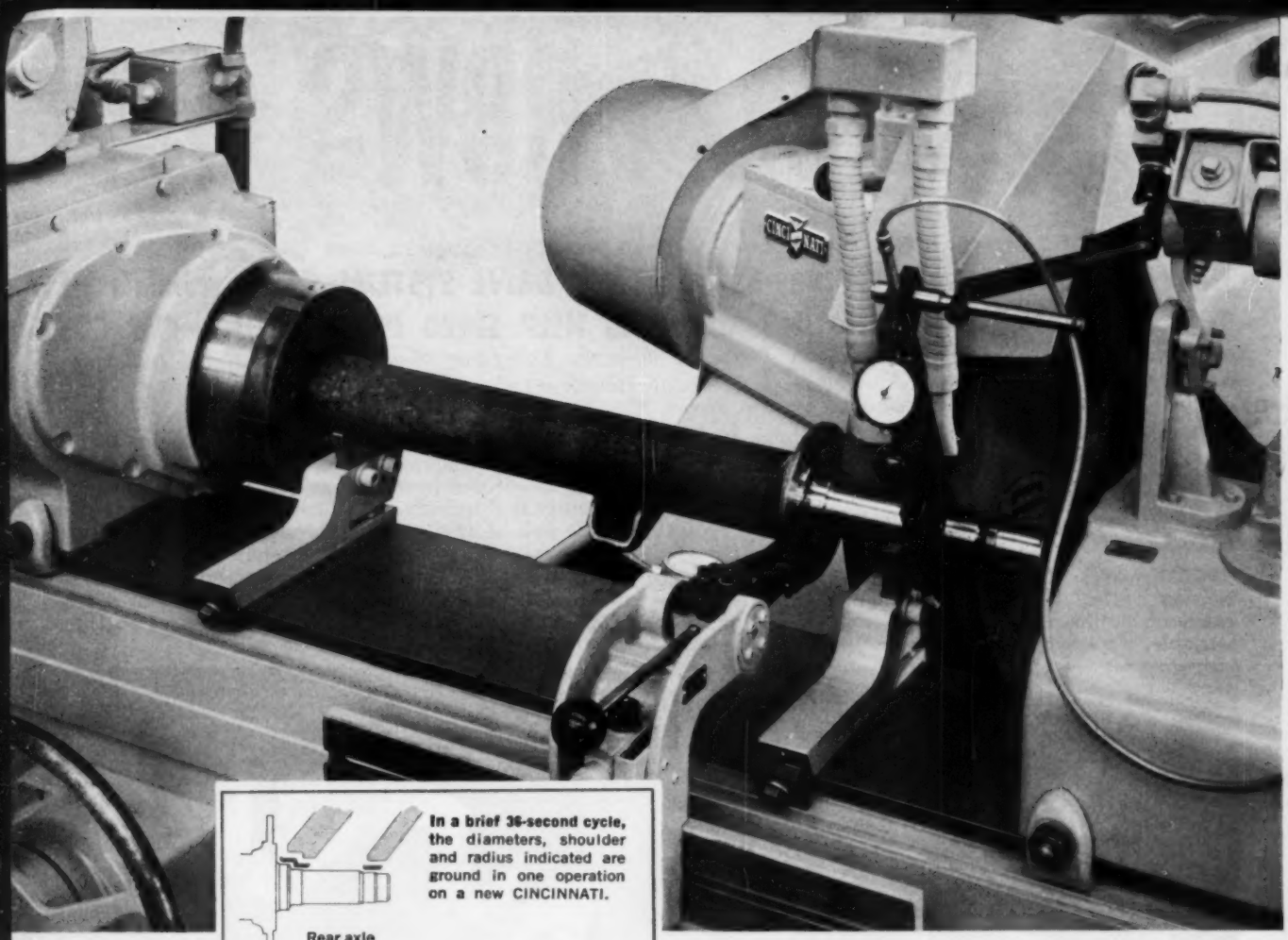
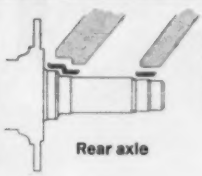
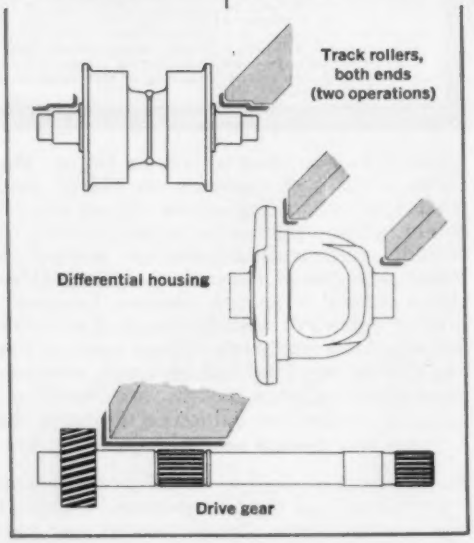




In a brief 36-second cycle, the diameters, shoulder and radius indicated are ground in one operation on a new CINCINNATI.

Rear axle

CINCINNATI GRINDING MACHINE DIVISION Incorporates Dependable Productivity

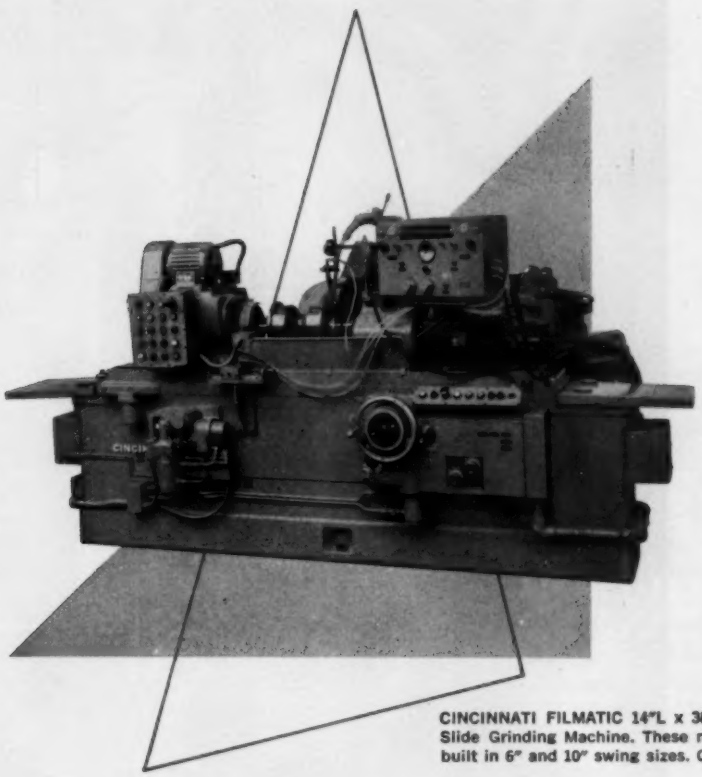


POSSIBILITIES UNLIMITED might well be the introduction to CINCINNATI FILMATIC Angular Wheel Slide Grinding Machines. The four drawings at the left are typical of the many combined operations assigned to these cost-reducing machines. In the photo above, *one operation on a new* CINCINNATI *combines three operations* formerly performed on three older grinding machines.

Wheel truing, perhaps the No 1 consideration in combining precision cylindrical grinding operations, is an exclusive automatic-cycle profile type, and can be manually started or automatically controlled through a counting device. The

BUILDERS OF PRECISION GRINDING MACHINES: CENTERTYPE • CENTERLESS • ROLL •

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

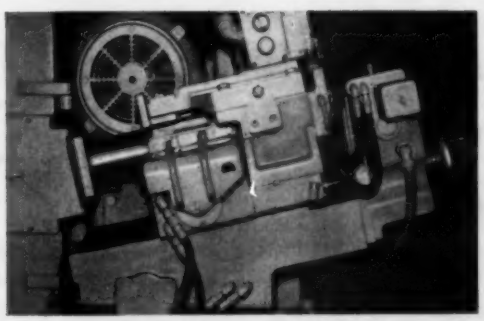


CINCINNATI FILMATIC 14"L x 36" Angular Wheel Slide Grinding Machine. These machines are also built in 6" and 10" swing sizes. Catalog G-686-1.

in Angular Wheel Slide Grinding Machines

machine's automatic infeed cycle incorporates rapid approach, coarse feed and fine feed rates for sizing and finish. For extra high production work where stock allowances are inconsistent, the Gap Eliminator can be included, to cut down the time spent in "grinding air." Automatic sizing and flagging are highly desirable quality control features.

The machine itself includes every element of Cincinnati quality construction and dependable productivity . . . FILMATIC grinding wheel spindle bearings . . . automatic hydraulic table clamp and nine additional feature-advantages. Get more details by writing for catalog No. G-686-1.



Push buttons at front of the machine control the wheel truing unit at the rear. Balanced hydraulic system and two-way truing assure precise duplication of cam contour in face of wheel.

CINCINNATI

CHUCKING • MICRO-CENTRIC • PRODUCTION LINES

CINCINNATI®
GRINDING MACHINE DIVISION

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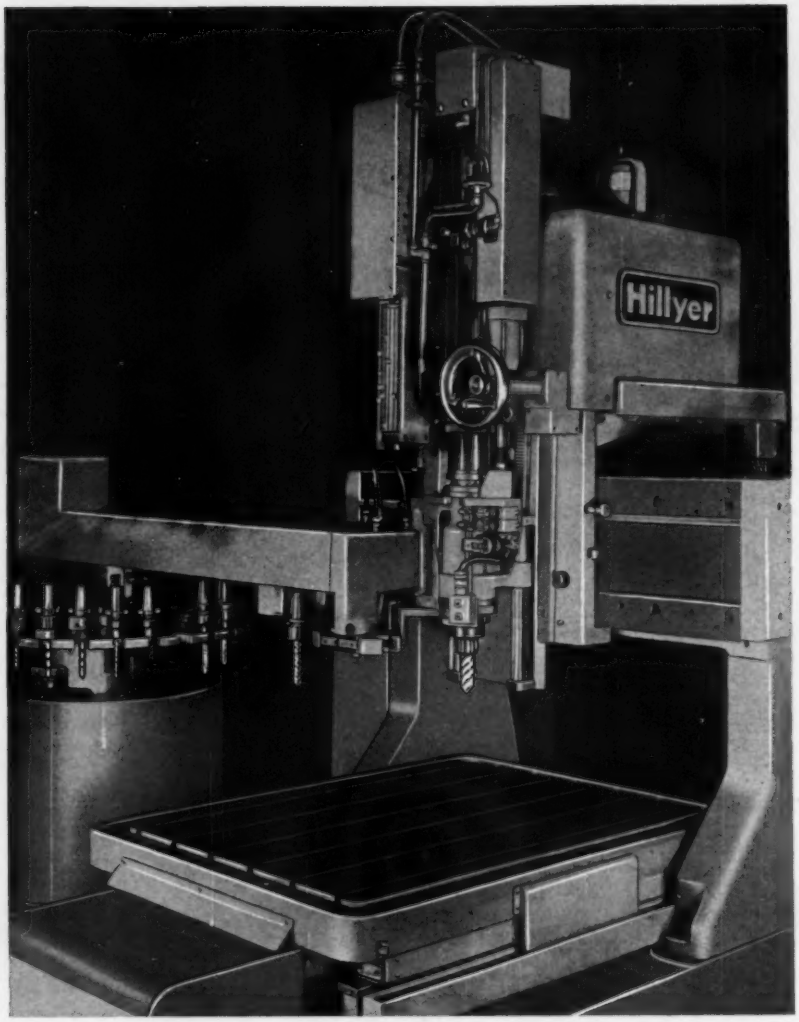


A numerically-controlled drilling machine with AUTOMATIC TOOL CHANGER

HILLYER'S NEW TAPE CONTROLLED DRILLING MACHINE WITH

AUTOMATIC TOOL CHANGER is **substantially less than its closest competition** — with features superior to them all! In addition to complete numerical control of all drilling, reaming, tapping and straight-line milling operations, the Model TC-36C automatically changes tools as designated by dial or tape. Any combination of spindle speed, feed rates, or depths can be selected at any time by dial or tape command. Any combination of these three variables can be selected at any time. And the machine permits a given tool to be programmed to varying levels and varying depths, all on the same work piece, all within a working range of 36″ x 24″. A total of 30 tools can be accommodated in the changer at any one time **—yet tool changing takes just seconds!** Write today for complete details to Dept. 321.

Hillyer
CORPORATION
244 Sheffield St., Mountainside, N. J.

Circle 657 on Reply Card

automation outlook

By **ROGER W. BOLZ**, Publisher and Editorial Director

WAY BACK IN NOVEMBER of 1958 we emphatically pointed out that a distinct change was taking place in the production machinery field. Our contention was that it was high time that builders of productive equipment recognized and viewed their basic business in its new role—production and process engineering.

Too much concentration on merchandising of machines has caused many builders to lose sight of reality. The really successful equipment builder's "stock-in-trade" is the manufacturing know-how and ingenuity that provides today's competitive edge for the buyer.

Although few could see the trend in early development, at long last today there is a growing awareness of the acute need. At the recent Design Engineering Show, Alan C. Mattison, past president of the NMTBA made the observation that, "what domestic manufacturers really need is a highly automated means of production . . . If we, who are close to the market needs, do not produce the machinery which makes our customers more competitive to their foreign competitors, then we are inviting a special kind of competition. Not just price competition, but the threat of superior products designed specifically for our markets—to solve our customers' economic problems."

It is even more emphatic when another fact is considered—our studies show that 84 per cent of today's major manufacturers design and build much of their own production machinery. Why? Because it has been difficult to get automatic manufacturing equipment developed and built to meet specific modern needs.

Times have changed. In lieu of selling a line of standard machines, the real goal must be selling successful economic solutions to modern production problems using as much automation technology as possible to attain long range cost and quality benefits. This basic change in approach is long overdue.

A RECENT BILL introduced in Congress by Rep. T. B. Curtis (R. Mo.) proposes personal income tax deductions up to $1500 for individuals who train for higher skilled jobs to avoid possible unemployment due to automation. Labeled as a "private enterprise" solution to the problem of technological displacement and changing demands in industry, the bill makes recommendations similar to those in my statement to the Subcommittee on Automation and Energy Resources, July 1960.

FIGURES MAY LIE on the financial pages! Writing in *Saturday Review*, Donald I. Rogers, business and financial editor of the Herald Tribune, makes a significant point that all our choice indices of business are suspect. Whether you use car-loadings, gross national product, Federal Reserve index of industrial output, or what have you, all fall far short of

being usefully accurate or representative of the real facts, Rogers observes. Even the unemployment index, he maintains, is questionable owing to the cardinal premise on which it rests. Among other faults it fails to separate "those who don't work because they don't want to and those who want to but can't." It makes a big difference!

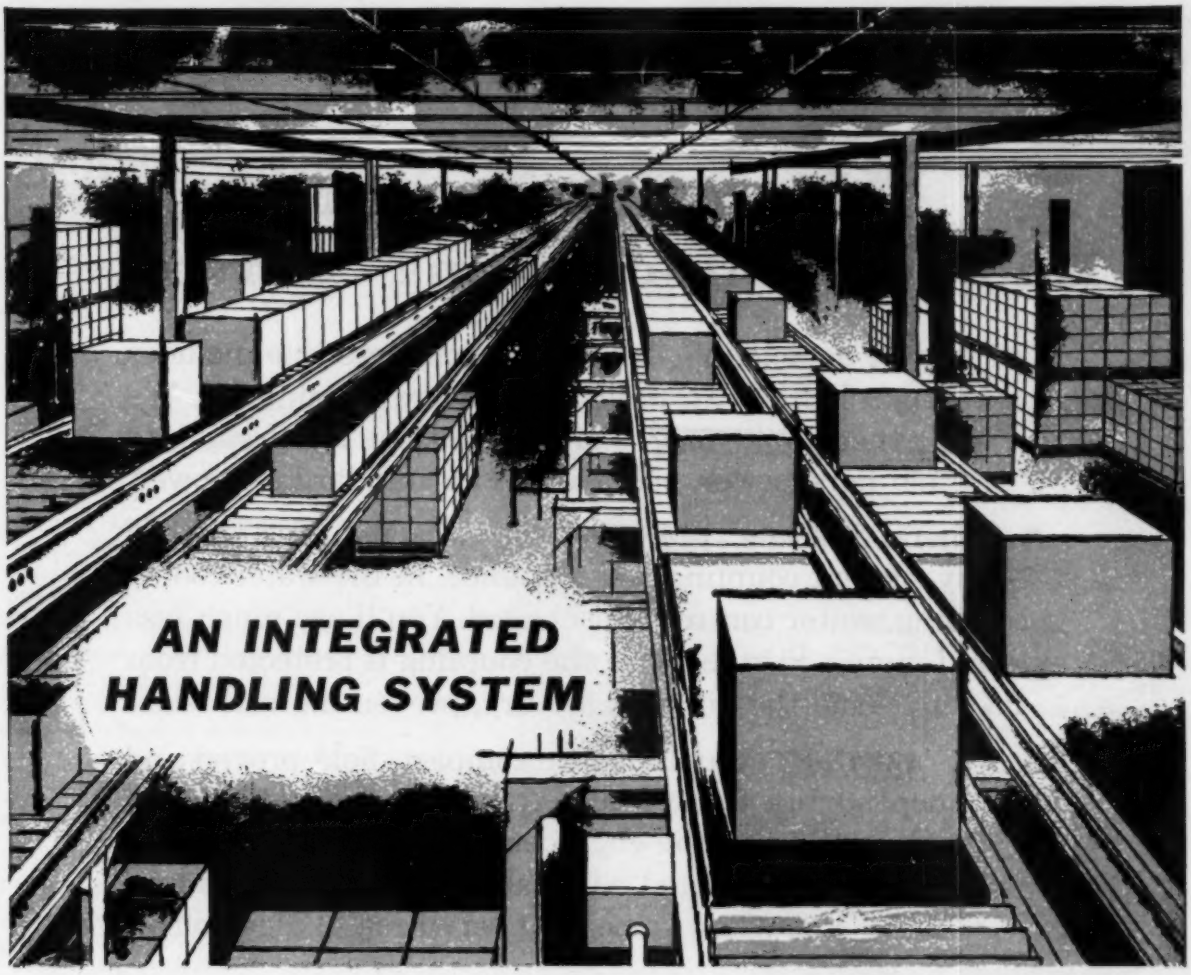
CONTINUING EDUCATION is the only really promising avenue to permanent mitigation of unemployment problems. In spite of the growing need for better education in an age of advancing technology, it has in the past decade become anything but more popular. To make it so will require a nationwide effort inspiring renewed individual initiative and quest for knowledge. Noting that we are entering a totally new world, Robert M. Hutchins says: "The demands of this new world, like the demands of the political community, are first of all intellectual. They are demands that we think and learn. We face them ill prepared."

COMPETITIVE RACE of the sixties will go not to the swift but to the well managed company says Sidney Lochan, vice president of James Talcott, Inc. "In other words," Lochan warns, "to the company that in addition to its traditional marketing activities fully develops its research, design, production and administration resources."

SOLUTION to the general problem of mobility and expanding job opportunities seems to be growing more difficult. The Glidden case, now waiting for Supreme Court decision, will decide whether seniority rights extend beyond contract times to limit ability of companies to move plants without taking all employees along. Another step away from free enterprise principles, such a cradle-to-grave responsibility will without doubt create another imposing barrier to desirable industrial growth and distribution.

IT DOES NOT TAKE MUCH INVESTIGATION to see that industry operates to a great degree with less than adequate data. "Modern management requires fast and accurate decision making based on reliable accounting and production facts collected as they occur," says Carl P. Spaulding, president of Datex Corp. "While electronic data processing is an important tool, its full potential will not be realized until this bottleneck is broken."

EVOLUTIONARY DEVELOPMENT characterized the Sixteenth Annual ISA Instrument-Automation Conference and Exhibit held in Los Angeles September 11-15. An unusually wide range of exhibitors present reflected the change in character of control systems that automation has created in industry. The equipment presented a usefully broad cross section of controls for automating manufacturing process equipment in just about any industry active today. The wedding of instruments and all kinds of control devices provides a new insight into the expanding scope of control systems in modern production installations.



Overhead conveyor system saves thousands of square feet of floor space.

...Engineered by ALVEY...

May Cut Your Package Handling Costs

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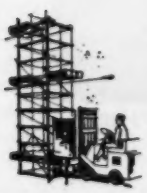
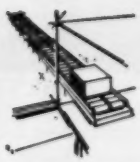
It doesn't pay to buy conveyors piecemeal. You don't have to throw away your present equipment and start from scratch, either.

Alvey's experienced package handling engineers can show you how to coordinate the workable parts of your present system with new elements for faster, easier, less expensive materials handling.

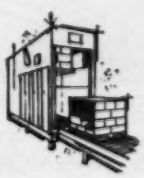
Or, they can build a complete system for a new plant, or total modernization program.

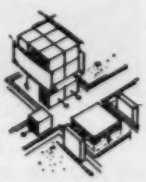
Remember, it's often more profitable to cut processing and handling costs than to make new sales. Call in Alvey, and reappraise your handling methods now.


Vertical Lift Conveyors

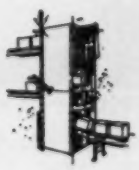

Telescopic Boom Conveyors

Air-Chain Conveyors


Pallet Loaders


De-Palletizers

Traffic Cop


Vertical Indexing Conveyors

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Circle 658 on Reply Card

General Electric Makes Eddy-current-coupling Drives

And they're dependable drives. The complete line includes water-cooled and air-cooled eddy-current couplings. We call them KINATROL* drives. Ratings are from 1 to 150 horsepower, operating from standard a-c power.

A General Electric KINATROL drive is not just another eddy-current coupling. For instance, in the water-cooled coupling, water control is packaged. You'll see much less external piping. Furthermore, the coupling is protected from flooding—and the air gaps are dry, preventing corrosion.

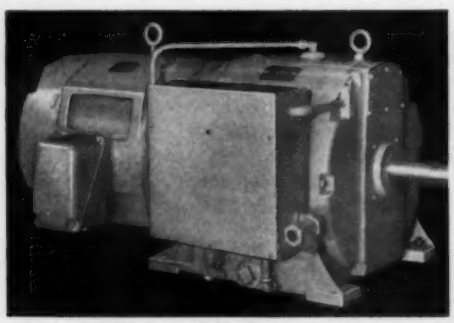
KINATROL couplings are compact, field proven and dependable. General Electric has had a good deal of experience in the engineering, manufacturing, and application of packaged adjustable-speed drives. And we know how important service is to a customer.

KINATROL —a good product, with the kind of service you can depend on. Please call your nearest General Electric Sales Office for further details.

*Trademark of General Electric Company

821-07

AIR COOLED, 7-1/2 to 100 HP



WATER COOLED, 25 to 150 HP

AIR COOLED, 1 to 5 HP

DIRECT CURRENT MOTOR AND GENERATOR DEPARTMENT

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Circle 659 on Reply Card

AUTOMATION news

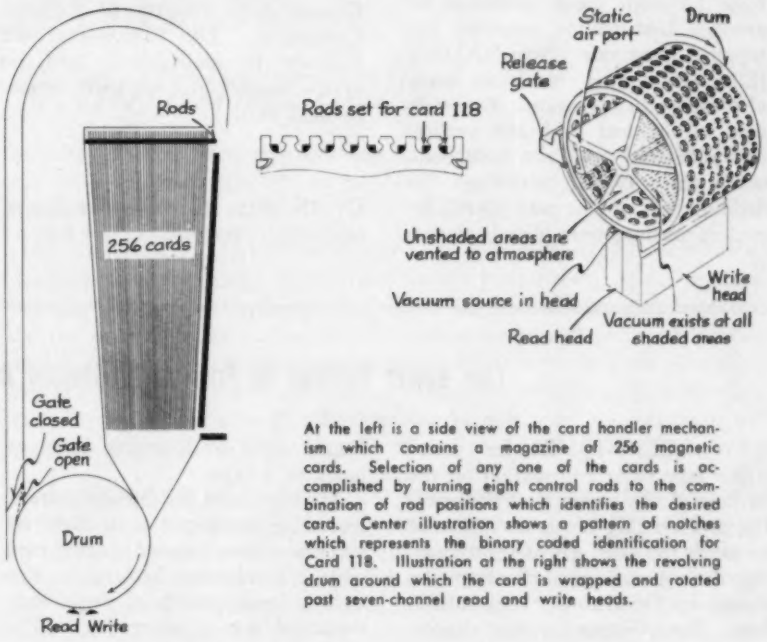
Today's events and developments in the field of automation

Random Access Memory Uses Magnetic Cards

NEW METHOD of storing data on magnetic cards has been developed by National Cash Register Co. for use on their 315 EDP system. A device, called the Magnetic Card Random Access Memory (CRAM), is designed so the long length of narrow magnetic tape is cut into short segments and the width is increased. The data does not have to be sorted in order to process it against a file, and the entire file does not have to be read to update a portion of it. Major components of this unit are: Card handler mechanism, control circuits for the card handler, and electronic circuits associated with processor-controlled data filing operations.

The card handler mechanism contains a magazine of 256 magnetic cards. Across the top of each card is a distinct pattern of notches which represents a binary coded address for the card. The cards are suspended from eight electronically controlled rods which can be positioned to drop any one of the cards. When a card is selected, all other cards are supported by at least one tab. Once dropped from the rods, a card wraps around a revolving drum, and rotates over seven-channel write and read heads that permit reading or recording data at the rate of 100,000 characters or 150,000 digits per second. The card is held in positive contact with the drum by a vacuum source and is accelerated to a drum speed of 400 ips. A vacuum surrounding the write head negates an air-layer which would otherwise separate the card from the head. Following the record head is a read head which allows a check of the write operation. After passing the read head, the card is returned to the magazine and slipped onto the selection rods, or it may be recirculated on the drum for additional read-write operations. Average access time to any one of the 256 cards is about 200 milliseconds. Through recirculation of a card, any bit of information can be reaccessed in an average time of 23 milliseconds.

There are seven data storage channels with a total capacity of 32,550 digits or 21,700 characters on each card, giving a single magazine a total capacity of 8,332,800 digits or 5,555,200 characters. Separation of the cards suspended in the magazine is provided by a low-velocity stream of air injected from above. This air stream is passed through a nozzle consisting of 256 separators. Any time one or more cards is displaced, an adjustment takes place to resume equilibrium, or nearly equal spacing between cards to insure that the cards will fall, free from the friction of the adjacent cards.



At the left is a side view of the card handler mechanism which contains a magazine of 256 magnetic cards. Selection of any one of the cards is accomplished by turning eight control rods to the combination of rod positions which identifies the desired card. Center illustration shows a pattern of notches which represents the binary coded identification for Card 118. Illustration at the right shows the revolving drum around which the card is wrapped and rotated past seven-channel read and write heads.

NATCO Opens New Plant Displays New Equipment

OPENING of the new and enlarged facilities of National Automatic Tool Co. Inc. in Richmond, Ind., presented them with the opportunity to display new equipment they are offering. One new line is induction heat treat equipment that case hardens gear teeth under water. This is available under a cross - licensing agreement with Delapena and Son Ltd. of England. Another unit displayed was a single spindle numerical control machine

with an automatic tool changer that is capable of handling 32 tools. This tool changer provides the fast tool change of random selection without the necessity of coding the individual tools. A twin-spindle numerical control machine arranged with two automatic tool changers was also shown. One spindle is designed for heavy milling and boring, while the second spindle is built for high speed operation for average sized drilling, reaming, and tapping operations. New NATCO/JES-CAL honing machines were also shown in operation. Both vertical mechanical feed and vertical hydraulic feed machines were demonstrated. Other machines for drilling and tapping and plastic injection molding were also displayed.

Pushbutton System to Sort Bulk Mail

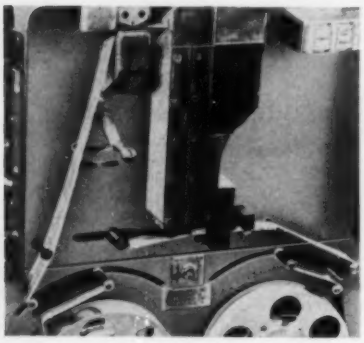
CONTRACT to install a pushbutton system to sort mail sacks in the Texarkana Union Station has been awarded to Atlantic Div., Aerojet-General Corp. The Texarkana terminal is the largest commercial mail handler in Texas, with volume ranging from 20,000 to 40,000 sacks per day. Principal users of the terminal are the Missouri-Pacific Railway, the Texas and Pacific and Kansas City Southern Railway Companies. The $535,000 system will also be adaptable to load the mail directly into company trucks or mail cars.

IN AN effort to broaden its line of electronic components, General Electric Co. announced that it will manufacture semiconductor diodes to be used in digital computers, microwave relay equipment, and industrial controls. The first product manufactured will be a silicon planar, epitaxial, passivated diode. It will be available with the same electrical specifications in both the conventional subminiature glass diode package and a hermetically sealed microminiature package. The microminiature package is designed for use where high packing densities are required and for use with thin film circuits.

CUT-OFF and deburring of ends of rectangular and circular steel tubing is accomplished with a tube end finisher developed by Lordstown Tool and Die Co. Inc. in co-

Tape Reader Operates On Principle Of Chopped Reflected Light

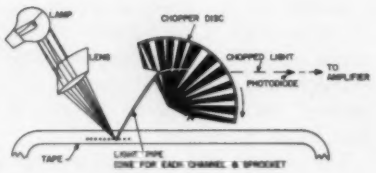
NEW TECHNIQUES for coded paper tape store information on the surface of the paper, and the reading or recording heads do not need to touch the tape. Units incorporating these techniques have been designed by Omnitronics Inc., subsidiary, Borg-Warner. An electrostatic recorder produces permanent, visible spots on the tape, and a reader uses the principle of chopped, reflected light to interpret spots or holes in a tape.



DATA RECORDER, shown in operation with the tape reeler, is a self-contained unit with its own power supply, tape drive, and controls. Device uses an electrostatic recording technique, replacing round punched holes with capsule shaped spots. This design permits reading and writing speeds in excess of 1000 characters per second.

The tape used for the electrostatic recording technique is a high resistivity plastic coated paper tape with a conductive backing. The writing head consists of two closely separated sets of electrodes. The electrodes are pulsed at write time and this causes a discharge, charging the surface of the paper through ion migration from the discharge cloud to the surface of the tape. The image is made visible by passing the tape through a bath of dry powdered ink which adheres to the charged area. From the ink bath, the tape is passed through the fixing station, and the spots are permanently fixed on the surface. Recording speeds are up to 600 characters a second with present models.

The tape reader uses chopped reflected light as the sensing technique. Light from a bulb is focused by means of a double convex lens into a narrow beam at an angle on the tape. A series of light pipes, one for each channel and sprocket, is fixed in position over the tape near the concentrated line of light and at the proper angle so that the light from the tape is reflected squarely on the rod ends and is directed through a rotating chopper to sensing photodiodes. Use of the reflected light principle permits the reading of all tapes, punched or printed, opaque, colored or transparent. The chopped light allows the use of ac coupling, eliminating the drift inherent in photocells and dc amplifiers. Oil spots and other changes in the opacity of the tape have no effect on the sensing.



DATA READER uses chopped reflected light as the sensing technique to interpret spots or holes in the tape. Light from a bulb is focused by means of a double convex lens into a narrow beam at an angle on the tape. A series of light pipes is fixed in position over the tape and at the proper angle. Light from the tape is reflected squarely on the rod ends and is directed through a rotating chopper to the sensing photodiodes. Where a hole appears, light passes through the tape and is not reflected.

CONTROL DENSITY and FLOW RATE of ON-STREAM LIQUIDS

...automatically!

Now liquid density and flow rate can be automatically controlled by these new Halliburton instruments ... the FLOW METER and DENSOMETER. Here are the details:

HALLIBURTON DENSOMETER is a direct acting instrument designed to continuously measure and record fluid density of the product passing through it. Variances in product density are signaled from the device to automatic valves which alter component input maintaining densities at pre-set levels. Operation of the Densometer in measuring density is completely independent of other fluid characteristics such as velocity, viscosity, pressure, etc. The Densometer is designed to maintain an accuracy of ±1%.

HALLIBURTON FLOW METER is an in-line device equipped with a flow-actuated turbine with long-life bearings. As fluid entry rotates the turbine, electronic pulses generated are routed to key up-line motor valves which maintain the flow rate at pre-set quantities. This inexpensive instrument requires no lubrication and is available in 1", 2", 4", 6", and 8" models with any end connections desired. Accuracy of the Flow Meter is designed for ±1%.

Other Halliburton Products for Automated Industries

NEW Pneumatic-Electrical Control Panel for Bulk Material Handling Equipment provides the operator with finger-tip remote control over flow line valves and motivating air supply valves.

POSITIVE SEAL Full Opening LO-TORQ PLUG VALVE with *teflon-insert* seals gas lines *bubble-tight* in high-pressure applications. Available in 1" to 3" sizes for working pressures from 1,000 to 15,000 psi equipped with threaded, flanged or scarfed end connections.

For more information on any of these outstanding new developments for automation, see your Halliburton man, or write direct to:

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Take a close look at this new limit switch! It's so immune to moisture, we'll guarantee it, electrically and mechanically, for one year or 10,000,000 operations . . . whichever comes first. We call it our Super-Sealed SL2-T. If you've ever had limit switch trouble caused by water, soluble oils, condensate or *any* kind of moisture, you'll want complete details. Call, write or wire.

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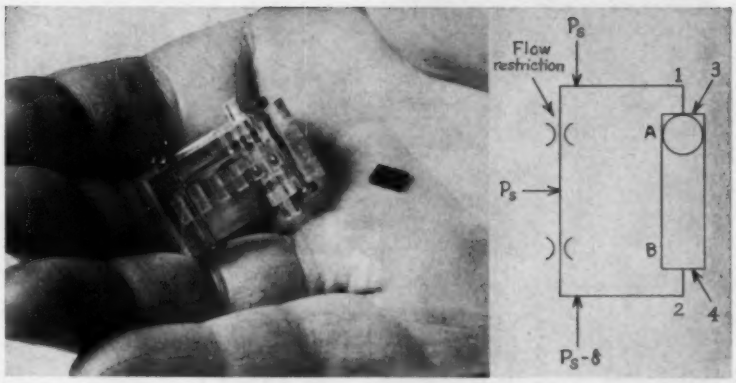
operation with Behr-Manning Co., Div., Norton Co. At the rate of seven to nine pieces per minute, tube ends are cut off by a pair of 20-inch Resinoid-bonded wheels, and deburred by four pairs of indexing wheels loaded with abrasive cloth. The deburring heads are rotated at 1200 rpm by 2 hp gear reduction motors, and are angled to produce a deburring action on both inner and outer surfaces. Alternate heads rotate in opposite directions. Working width of the machine can be varied from 42 to 155¾ inches and is adjusted by a powered worm.

OFFICERS and directors for the 1961-62 term of office of the Manufacturing Engineering Council were recently elected. President for the coming year will be **Harry Hibler**, manager of manufacturing engineering and research, Designers for Industry Inc.; vice president will be **Walter A. Stadtler**, director, manufacturing engineering, IBM Corp. Treasurer will be **Fredrick I. Ellin**, chief production engineer, Ohmite Mfg. Co.

EDP System Applied to Fastener Manufacture

ELECTRONIC data processing equipment to handle manufacturing data has been installed in the fastener and metals divisions of H. M. Harper Co., manufacturer of corrosion resistant fasteners and extruded stainless steel and alloy industrial shapes. The equipment, based on an IBM 305 Ramac, will co-ordinate all major functions of the company including inventory control, machine load and scheduling, sales forecasting, raw material, finished goods, and order filling. It is one of the first firms in the industry to use a computer in a total manufacturing control application.

The 50-disc memory file in the system is capable of holding up to 10 million characters of information. Data is fed to the discs via punched cards and can be printed out at the rate of 150 lines per minute. A movable arm can locate information on any disc at random in less than a second. A complete stock status report of the company's 15,500 separate products is stored on the magnetic discs. In an instant, the computer reveals the quantity of each part on hand and automatically signals when a predetermined re-order point is reached. The system can then be instructed to automatically type restock orders. The computer will also be capable of checking a customer's order against inventory, preparing shipping orders and invoices, and serving as a master control over all phases of manufacturing from machine scheduling to



Device To Compute With Air

PNEUMATIC COMPUTER, developed by Kearfott, Div., General Precision Inc., is based on the pneumatic instrumentation of the diode and the bistable amplifier; resistance, inductance and capacitance; and use of the principles of the acoustic transmission line. The device uses a moving part providing a direct means of converting between electrical and pneumatic signals, eliminating the need for additional volume or complexity to accomplish this in the pneumatic computer. The tiny black box on the right in the man's hand is a full size replica of a pneumatic computer module containing six bistable elements, or flip-flops. Elements can be packaged to a density of around 3000 per cubic inch. The module can perform the same functions as the transparent model on the left.

The conversion from pneumatic to electrical signals is derived from the position of the moving part by means of a coil, or by capacitor plates or contacts embedded in the walls of the cylinder of the bistable element. The conversion from electrical to pneumatic data is accomplished by forcing shuttle motion magnetically or electro-statically.

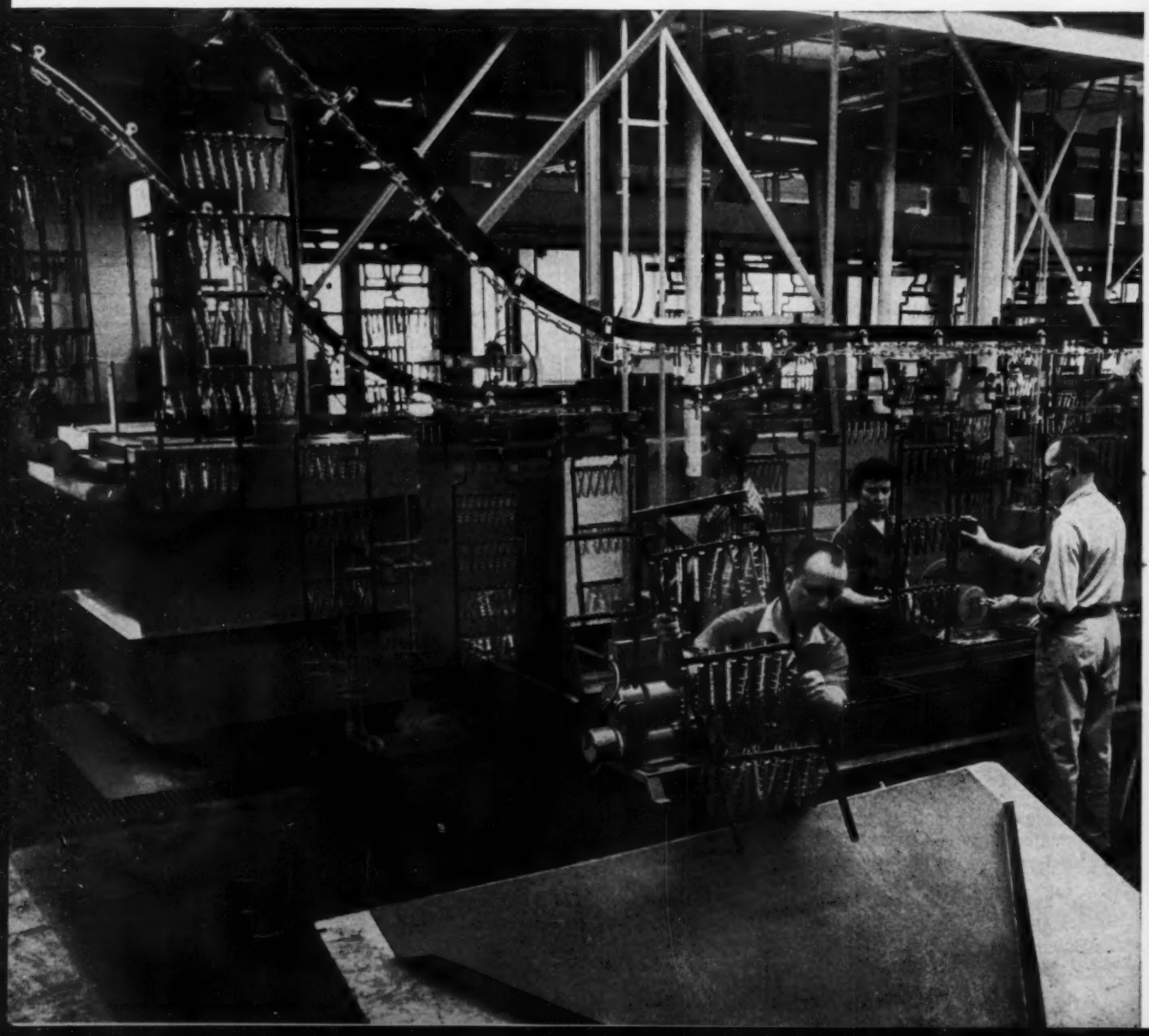
The device can be operated in a number of different ways. The two axial connections, 1 and 2, are supplied through separate flow restricting orifices by a common pneumatic supply at a pressure P_s. The radial connections, 3 and 4, are open to the atmosphere. The ball is initially at position A. Major flow is through the supply orifice for inlet 2, and out through 4. Since the ball does not provide a leaktight fit in the cylinder, a small flow passes around the ball and out through 3.

Three factors result in forces on the ball: P_s acting on the area of the seat opening and tending to force the ball away from A; the pressure in the cylinder acting on the entire ball area, urging the ball toward A; and a very small pressure on the ball area less the seat area due to the back pressure at 3, tending to force the ball away from A.

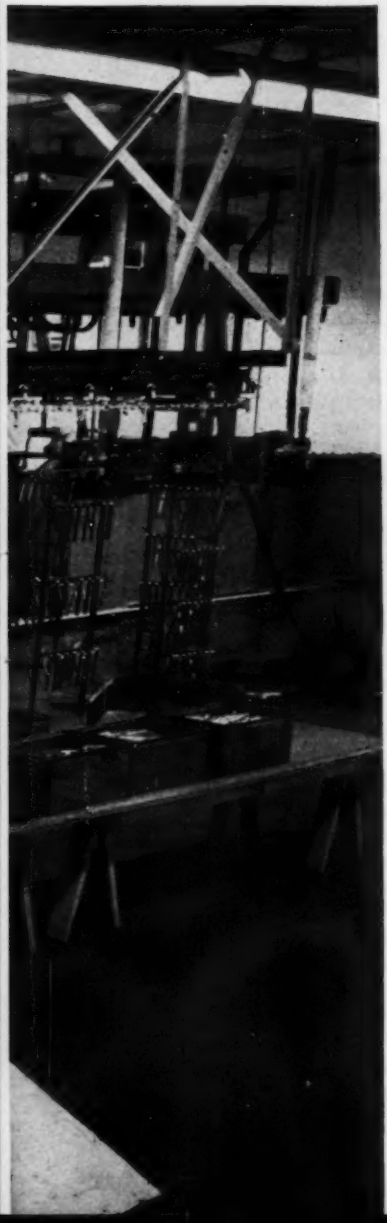
If 3 is closed, pressure in the cylinder on both sides of the ball will equalize because of leakage between the ball and cylinder wall. The force acting on the seat area which will move the ball away from A will remain. As soon as the seal between the ball and seat A is broken, the supply pressure acts on the entire ball area, and the ball is driven rapidly to B.

Since a pressure pulse applied at a radial connection of the bistable element has the same effect in inhibiting outward flow as a closure, the device can also be operated as a pulse-responsive device. In the case of pressure rather than closure input, the actuation time of the element will be reduced, since dependence is no longer placed entirely on leakage past the ball to bring the unit to the trigger point. The output of the device can be taken as the pressure drop across the supply orifices. Pressure gains as high as 100 for a single stage are feasible.

here's plating automation



at its best!



Udylite Cyclemaster ties into plant conveyor system, features automatic rack loading and unloading mechanism

A fully-automatic Udylite Cyclemaster was selected by Koelling Metal Parts, St. Louis, Missouri, to meet high-production, high-quality plating requirements on looseleaf binder and catalog components. This 15-station machine with automatic load and unload mechanism, shown above, is tied directly into a "stop and go" overhead plant conveyor system for maximum material flow efficiency. ■ This Udylite Cyclemaster provides peak production flexibility for Koelling. It operates at any rate from 40 to 120 racks per hour with plating thickness easily varied from .0001″ to .001″. Parts of any size can be plated within the limits of the 16″ x 8″ x 36″ racks. ■ The Cyclemaster maintains exacting quality control standards, boosts plating volume and offers an important reduction in floor space requirements. To find out how you can obtain the ultimate in automatic plating today at a surprisingly low cost, call your Udylite Representative and have him tell you the complete Cyclemaster story. Then, let Udylite Engineers recommend the specific machine and conveyor system to best meet your requirements.

Udylite

THE UDYLITE CORPORATION
DETROIT 11, MICHIGAN

Circle 662 on Reply Card

final assembly. Status reports on every order are kept current, and production orders are being scheduled on nearly 300 machines up to 14 weeks ahead.

Data System Links Social Security Offices

ELECTRONIC EQUIPMENT, capable of transmitting 18,000 data characters in a single second, has been developed by Radio Corporation of America. Magnetic tape terminal units are in use in San Francisco and Kansas City to speed social security data. Facts and figures are sent from San Francisco to a computer system at Kansas City and are relayed back to San Francisco the same day. Data transmitted between the two locations are social security records, and certify benefit payments to the retired, widowed, and orphaned.

Through magnetic core memories, data are relayed to standard telephone, leased line, or microwave hookups. At the receiving end, the information passes through magnetic core memory and on to a magnetic tape unit for recording and computer processing. The use of core memory provides the highest rate of line efficiency by blanking out tape gap time.

The operator at the sending end of the line can dial the receiving point directly, receive confirmation that a connection has been established and start data transmission by pushing a button on the control panel. Voice communications between sending and receiving operators are possible, without affecting the recording of basic data.

INSTRUMENT Society of America recently elected officers for the 1961-62 year. New president is **Philip A. Sprague**, president, Hays Corp.; **Nathan Cohn**, vice president, Leeds & Northrup Co., will be president-elect-secretary. Vice president of the Standards & Practices Dept. will be **John R. Mahoney**, superintendent, Union Carbide Nuclear plant, and vice president of the Technical Dept. will be **Dr. Benjamin W. Thomas**, director of Instrumentation Physics Research, Texas Butadiene & Chemical Corp.

Seven-State Pipeline To Be Controlled Remotely

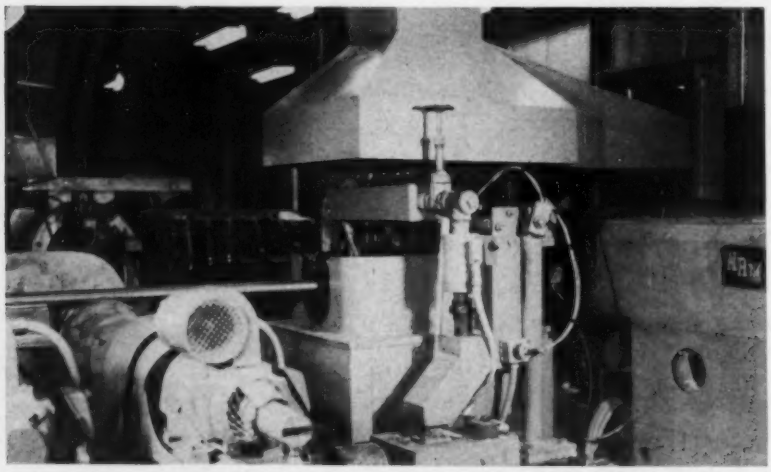
CONTRACT, involving the installation of controls on fourteen pump stations in a pipeline system, has been awarded to North Electric Co. by Mid-Valley Pipeline Co. Supervisory control and telemetering equipment will be provided to automate a 930-mile pipeline network extending from Longview, Tex. to Lima, Ohio. Fourteen pumping stations will be automatically controlled by a dispatcher at a central control station. Supervised indications, alarms, and field data quantities will be telemetered back to the central control point, providing the dispatcher with the necessary information to maintain optimum pipeline operating conditions.

Each of the fourteen stations will have a local sequence control panel to bring an engine or electric motor on or off the line, including motor-operated valve controls which need to be opened or closed during the start-up or shut-down cycle. The controlled stations are powered by electric motor or gas-diesel engine prime movers.

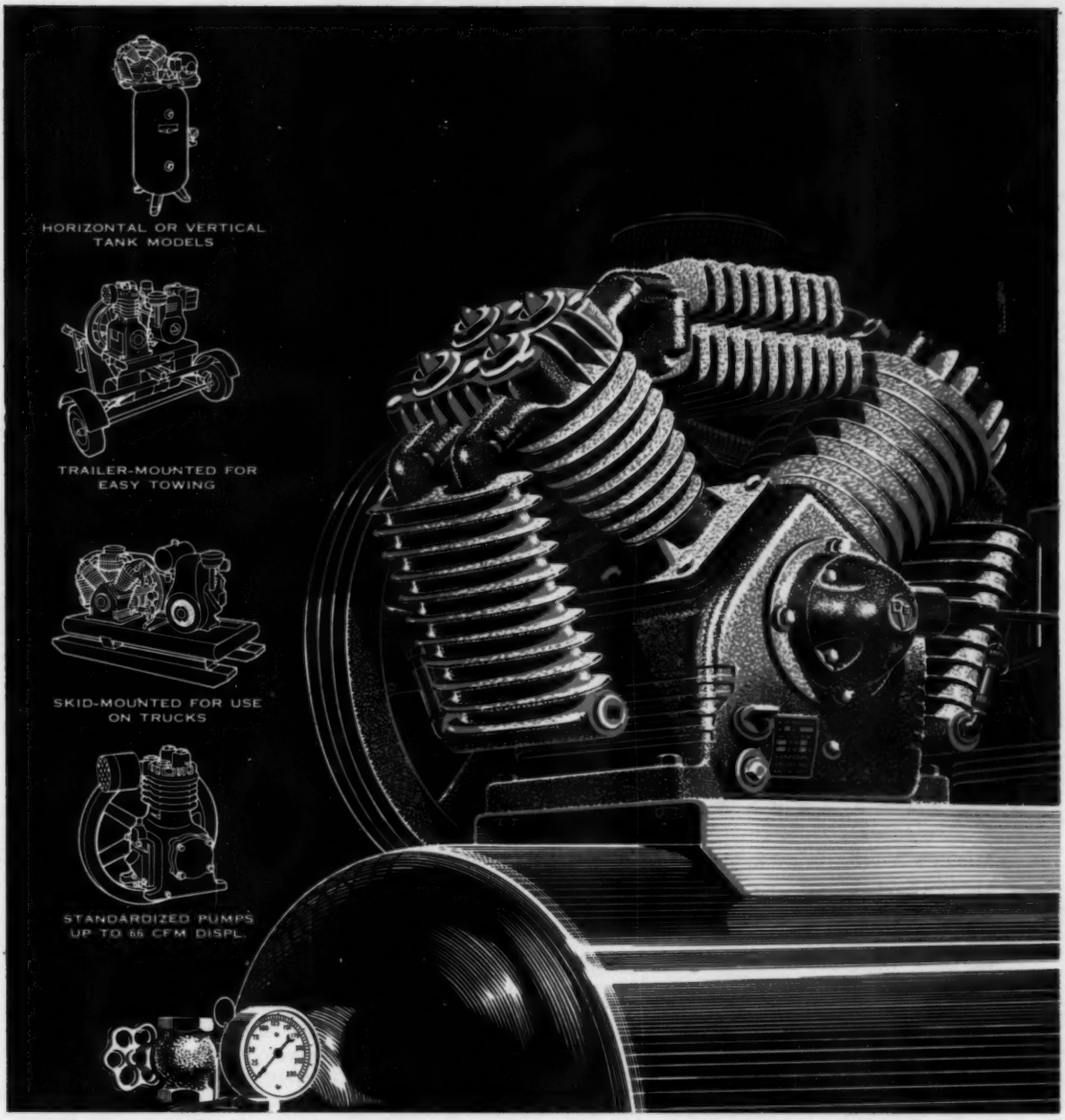
New Service Schedules Projects

COMPUTER SERVICE, which uses Project Evaluation and Review Technique (PERT) and Critical Path Scheduling, has been introduced by the Service Bureau Corp., subsidiary, IBM. The service, called Project Control Methods, is used to plan and evaluate what must be done to accomplish a complex project on time. A network or visual flow chart of sub-projects, showing the time it will take to complete each task, is first drawn up by management and the information is then processed on a computer. The results clearly pinpoint critical and potentially critical elements of the project. Alternate decisions can be simulated on a computer prior to implementation to study their effect on project deadlines.

ANNUAL AWARD to recognize outstanding individual achievement in the field of fluid power has been established by the National Fluid Power Association. The achievement award will recognize contributions to the field of hydraulic or pneumatic power in areas of engineering, research, development, design, sales, production, invention, and publications. It will be conferred for the first time in 1962. Nominees will not have to be mem-



ELECTRICALLY HEATED unit, manufactured by Sta-Warm Electric Co. continuously applies rubber-asphalt base compound to pipe at Republic Steel Corporation's Youngstown District mill. The unit maintains the temperature of a thermoplastic adhesive at 350F. The adhesive is received in solid form, heated to the prescribed viscosity, and transferred to a 50-gallon application tank by an electrically heated line. As the continuous length of pipe moves through the applicator, three nozzles apply a covering of thick adhesive to it. Excess material drops into a tank for recirculation and application. After the pipe receives its coating, a covering of heated yellow polyethylene is applied over it by extrusion.


HORIZONTAL OR VERTICAL TANK MODELS
TRAILER-MOUNTED FOR EASY TOWING
SKID-MOUNTED FOR USE ON TRUCKS
STANDARDIZED PUMPS UP TO 65 CFM DISPL.

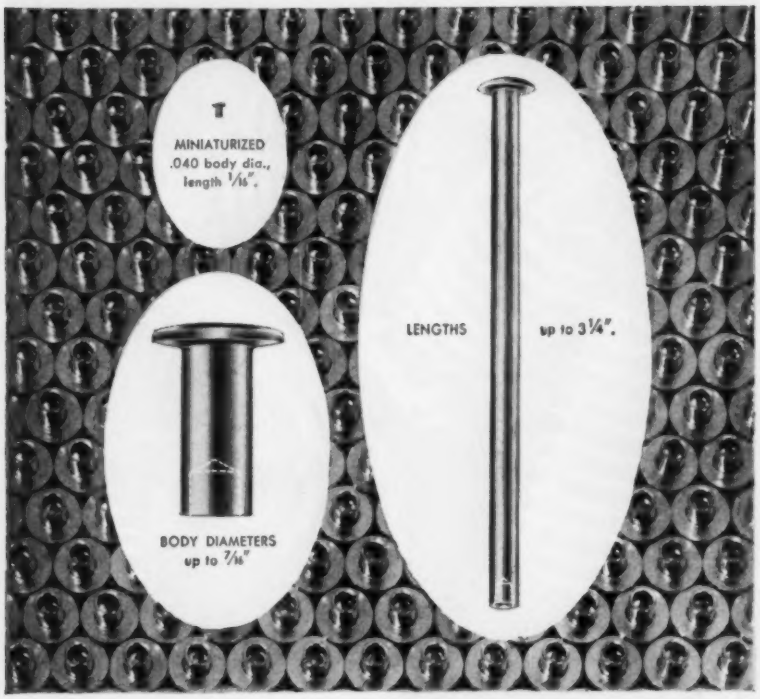
air compressors from DeVilbiss have greater finned cooling area, give you more air per power dollar. They're part of DeVilbiss' complete line of matched equipment for coating and finishing that includes: spray guns, automatic spray, dip and flow coaters, spray booths, air and fluid hose, ovens, spray washers, air-replacement units, dust collectors, complete "turn-key" finishing systems.

Talk to DeVilbiss about all your compressed-air needs thru 25 hp.

FOR TOTAL SERVICE, CALL
DEVILBISS

THE DeVILBISS COMPANY, Toledo 1, Ohio. Also Barrie, Ontario; London, England; São Paulo, Brazil. Branch offices in principal cities.

Look at this Size Range of Semi-Tubular Rivets... it's the way to lower cost



Miniaturized components and also large complete assemblies can now have all the money-saving advantages of using single and multiple automatic riveting. This is due to the wider size range of semi-tubular rivets now available and which can be used in conjunction with motor and pneumatic driven automatic riveting machines.

Today, there is hardly a fastening problem, involving even fragile materials, that does not warrant consideration of low-cost semi-tubular rivet setting.

Our Factory Riveting Specialists are ready to help you obtain the REAL COST FACTS on your own specific fastening problem. There is no obligation.

FOR YOUR FILES

Chicago Rivet Catalog describes 1388 standard tubular and split rivets and 25 single and multiple automatic rivet setters.

AIR-POWERED RIVETING

contains description and specifications of 8 single, multiple riveters— also rivet setters designed for automated operation.

Chicago Rivet & MACHINE CO.

943 So. 25th Ave., Bellwood, Ill. (Chicago Suburb)
Branch Factory: Tyrone, Pa.

Circle 664 on Reply Card

bers of NFPA or affiliated with member companies.

CALCULATING AID solves basic temperature-pressure and specific-gravity equations for sizing any rotameter-type instrument made by any manufacturer. Calculator consists of two circular slide rules, one for solving liquid-service equations and one for gas and steam-service equations. A single setting of the process variables on the slide-rule scales provides the user with a sizing factor. When this factor is multiplied by the maximum desired flow of the gas or liquid to be metered, the value of an equivalent flow of air or water is given at standard temperature-pressure conditions. Calculator can be obtained at nominal cost from Brooks Instrument Co.

TRANSISTORIZED, point-to-point numerical control system for machine tools has been developed by Thompson Ramo Wooldridge Inc. It provides tape control equipment for boring, drilling, and similar machine tools that require positioning in one plane only. The equipment can be programmed to one ten-thousandth of an inch, and has full control of acceleration and deceleration of the machine tool.

SPOTLIGHTING PEOPLE

Louis B. Young named general manager of the Bendix Systems Div., Bendix Corp. . . . **Dr. David B. Brandon** joined Information Systems Inc. as manager of the Process Control Dept. . . . **William F. Rogge** appointed general manager of the Industrial Div., Aeroquip Corp. . . . **Roy D. Jablonsky** named manager of the Servo Component Div., Giannini Controls Corp. . . . **Allwyn B. Williamson** appointed vice president and general manager of the Bearing Div., McGill Mfg. Co. . . . **Leland A. Kelson** named resident manager of the Lebanon, Oreg. mill division at Crown Zellerbach Corp. . . . **Robert E. Hess** appointed general manager of ABC Scale Div., McDowell Co. Inc. . . . **Dr. John D. Beierle** appointed supervisor of elec-

New Model

FRACTIONAL HORSEPOWER

DYNAMATIC AJUSTO-SPEDE® DRIVE

EATON DYNAMATIC

Steps up Reliability and Durability

New in design but a veteran of proven dependability, the Eaton-Dynamatic Fractional HP Ajusto-Spede Drive offers a compact, low cost solution to adjustable speed control problems. Improvements include:

- **Longer operating life**
- **More uniform cooling**
- **Less noise and vibration**
- **Lighter weight**
- **Compact design**

The Ajusto-Spede Drive offers advantages not found in other methods of control. It is low in cost and easily installed. It is an integral combination of AC constant speed induction motor, eddy-current couplings, and single tube, electronic control. Special control functions, such as acceleration, inching, threading, cascading of multiple units, follower operation, constant tension and clutch motor operation can be provided by remotely mounted electronic controls.

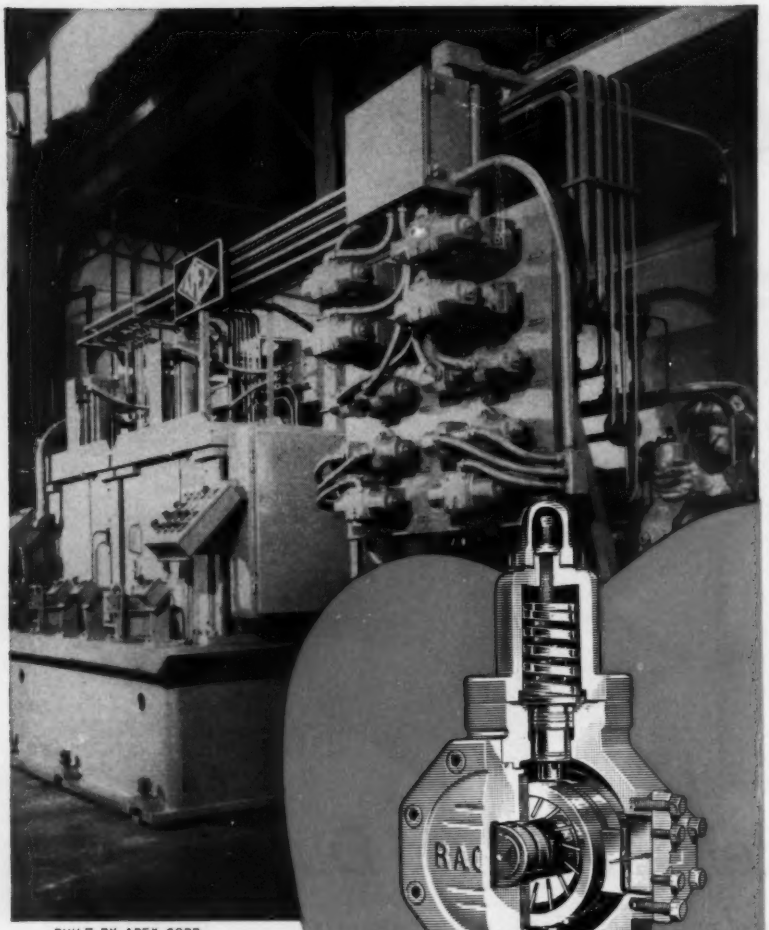
Ajusto-Spede Drives operate on standard 115/230 volt, single phase, 60 cycle or 220/440 volt, 3 phase, 60 cycle alternating current. No special power source is required. Available from the manufacturer or from your nearest Dynamatic Distributor in sizes of ¼, ½, and ¾ HP at 1600 RPM and ½, ¾, and 1 HP at 3200 RPM. Can be supplied with either of two types of electromagnetic friction brakes and integral speed reducer in a wide variety of gear ratios.

Send for Illustrated Descriptive Literature

EATON — DYNAMATIC DIVISION — MANUFACTURING COMPANY

3122 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

..Your partner in progress through research...



BUILT BY APEX CORP., ROSEVILLE, MICHIGAN

This active hydraulic heart helps

SEAL POROSITY IN 106 TRANSMISSION CASES EVERY HOUR

A RACINE VARIABLE VOLUME PUMP and 10 RACINE VALVES control *all* mechanical operations in this Apex impregnating machine, which seals leaky transmission cases at a major auto firm's transmission plant in Toledo, Ohio. Apex specified RACINE equipment because its design simplifies machine design problems . . . eliminates the need for extra pumps and valves. RACINE PUMPS are easy-to-control . . . handle pressure compensation *automatically* for varying gpm requirements. Apex has *preferred* RACINE for over 10 years!

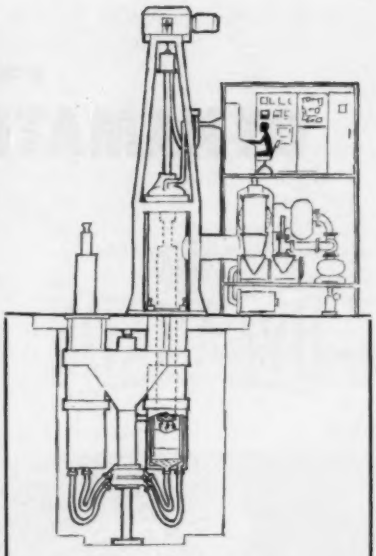
the HEART of this impregnating machine is a RACINE MODEL 6FA PUMP

RACINE

Racine Hydraulics & Machinery, Inc.

RACINE, WISCONSIN

HYDRAULICS DIVISION

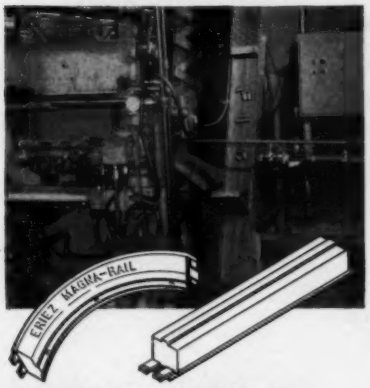


VACUUM ARC furnace, developed by Consolidated Vacuum Corp. has a crucible support similar to a lazy susan which allows ingot removal by rotation of the support. Simultaneously, a new crucible is rotated into position by the operator. Previous methods required the use of heavy cranes to remove the crucible assembly and put a new assembly in place. Features of this furnace include automatic control of the arc, providing even melting and removal of impurities. A new design of controls for raising and lowering the consumable electrode allows minimum inertia and brief response time and the removal of ingots in minimum time.

tronic switching systems planning and **John E. Fulenwider** named supervisor of electronic switching techniques, both in the research department of Automatic Electric Laboratories Inc. . . . **John J. Graham** appointed division vice president, operations of the Electronic Data Processing Div., and **Francis J. Dunleavy** named general manager of Communications and Controls Div., both at Radio Corporation of America. . . . **John vonRosen** appointed director of the corporate manufacturing staff and services and **Hayward F. York** named manager of manufacturing engineering for Chrysler Corp. . . . **Lawrence B. Miller** appointed manager, manufacturing administration and plant facilities for the Industry Control Dept., General Electric Co. . . . **Dr. Grace L. Hopper** named director of systems research for the Remington Rand Div., Sperry Rand Corp. . . .

ERIEZ *Magnetic Minute*

60 seconds that will help you improve operating efficiency.



CONVEY, CONTROL, ELEVATE FERROUS PARTS faster...safer

Do it magnetically . . . with MAGNA-RAILS — from the Eriez line of Magnamation® (magnetic automation) components.

Powerful magnetic action holds items ranging from tiny tacks to large finished parts at fast speeds, up or down inclines as steep as 90°. You can convey on top **and** bottom sides of your lines; turn parts over automatically; change direction of flow, etc.

Use of steep inclines shortens belt spans, permits close grouping of machines to conserve valuable floor space. Positive hold prevents slippage of parts—reduces damage, cuts need for manual handling, increases safety.

Eriez field engineers will gladly show you exactly how MAGNA-RAILS help you move materials faster, safer, more economically, more efficiently . . . either on new or existing lines. Write to:

ERIEZ MANUFACTURING CO.
119YA Magnet Dr., Erie, Pa.
ERIEZ OF CANADA, LTD.
P.O. Box 5, Sta. W—Toronto, Ont.

MAGNA-THOUGHT

By using exactly the right magnetic material for a given application, Eriez can provide each customer with precisely the right equipment to do a particular job.

W. J. FALLER
Product Mgr. Automation

ERIEZ

A GROWTH COMPANY...
10 NEW PRODUCTS IN THE LAST 5 YEARS

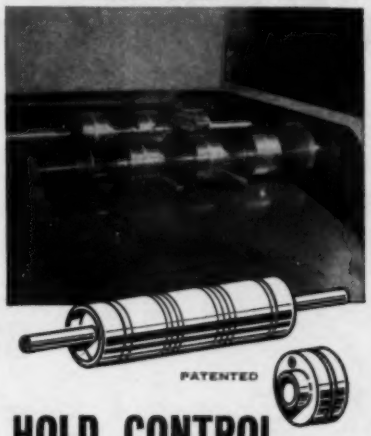
Circle 667 on Reply Card

Roy L. Ash elected president of Litton Industries Inc. . . . **Elwood F. Rogge** named director of manufacturing at Leeds & Northrup Co. . . . **Richard S. Sheetz** elected executive vice president of Ohio Crankshaft Co. . . . **Fred L. Martinson** named vice president of the newly formed engineering and manufacturing division at Electronic Associates Inc. . . . **John J. Moran** elected executive vice president of Sigma Instruments Inc. . . . **Charles W. Brunstetter** appointed general manager of Ipsen Industries Inc. . . . **Wilhelm F. Juptner** named vice president of Babcock Relays, Div., Babcock Electronics Corp. . . . **Chalmer E. Jones** named vice president and director of John Diebold & Associates Inc. . . . **George A. Banino** elected vice president and general manager of the Communications System Dept. of ITT-Kellogg, Div., International Telephone and Telegraph Corp. . . . **John Powers** named vice president/operations and **Henry De Matteo** appointed manufacturing and works manager, both at Verson Allsteel Press Co. . . . **Eugene A. Bartkus** appointed vice president, research and development at Meissner Engineers Inc. . . . **Herbert E. Weyrauch** named general manager of the Electronic Controls Div., Flo-Tronics Inc. . . . **Charles A. Kautzer** appointed chief

BAR CHART RECORDER can monitor cost and production control information from as many as 40 machines. The recorder is connected to the machines by telephone-type wires. Information is recorded on an inkless chart with 40 vertical bars or channels. Every 20 seconds the recorder samples and graphically records each machine's performance. When the machine is operating, this action is recorded with a short horizontal line in the appropriate bar or channel area. If the machine is idle, lines do not appear. Unit is manufactured by Electronic Associates Inc.

ERIEZ *Magnetic Minute*

60 seconds that will help you improve operating efficiency.



HOLD, CONTROL, ELEVATE, CARRY

ferrous materials magnetically

Do it with MAGNA-ROLLS — from the Eriez line of Magnamation® (permanent magnetic automation) components. They're particularly valuable in speeding and simplifying sheet handling.

Use Magna-Rolls as magnetic head pulleys to carry ferrous materials up and over or down and under belt conveyor lines. Use them singly or in multiples for feeding, conveying and controlling parts on non-belt systems. As magnetic feeders to control and feed sheets, blanks and formed parts to various operations, and many other ways too!

Magna-Rolls can be furnished in diameters ranging from 2½" to 30". Erium® powered magnetic strengths and field depths can be furnished to meet specific requirements. In the wide range of standard and modified standard units you will almost certainly find a simple, economical solution to your specific handling or conveying problems.

Full data on Eriez Magnamation components is available in our newest Bulletin. Write for it to:

ERIEZ MANUFACTURING CO.
119YB Magnet Dr., Erie, Pa.
ERIEZ OF CANADA, LTD.
P.O. Box 5, Sta. W—
Toronto, Ont.

MAGNA-THOUGHT

Most of the very first installations of Eriez equipment are performing as effectively today as they did when they were new, years ago.

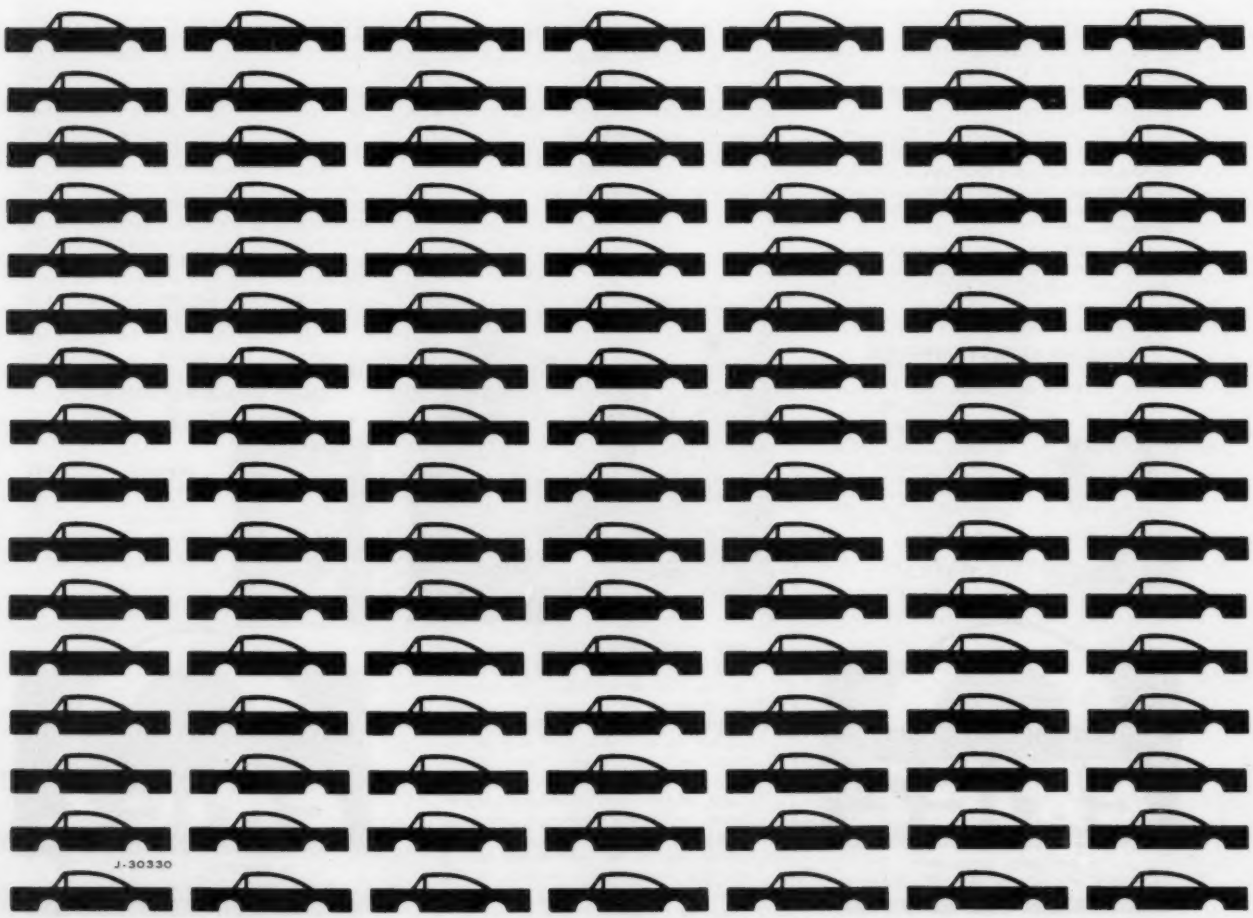
A. F. ISRAELSON
Chief Engineer

ERIEZ

A GROWTH COMPANY...
10 NEW PRODUCTS IN THE LAST 5 YEARS

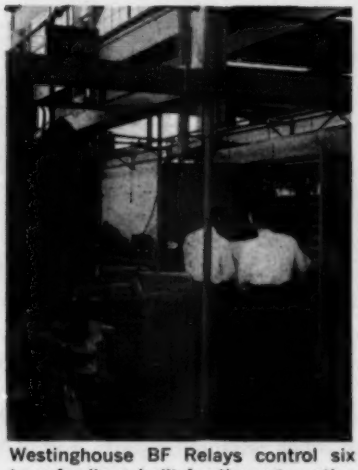
Circle 668 on Reply Card

The Westinghouse BF Relay is helping the automotive industry solve its floor space problem. One automotive customer was able to reduce the length of a single control panel from 36 feet to 22 feet. Another eliminated one of three panels. The Westinghouse BF Relay is a new concept in relay design tailored to space-saving needs of automation. As many as four BF Relays fit in the space of



one old style relay. Besides being small, performance excels other machine tool relays. Learn how it can help you gain valuable floor space for more productive uses. Contact your Westinghouse sales engineer or write: Westinghouse Electric Corporation, Standard Control Division, Beaver, Pennsylvania. *You can be sure . . . if it's* **Westinghouse**

Automotive industry saving thousands of dollars in floor space with the new Westinghouse BF Relay

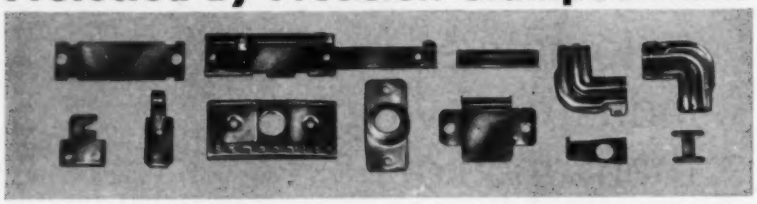


Westinghouse BF Relays control six transfer lines built for the automotive industry by F. Joseph Lamb Co., Detroit.

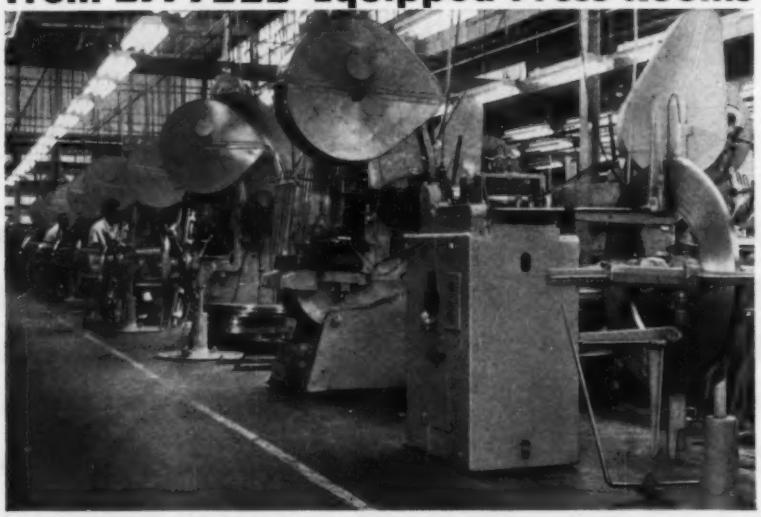
Circle 669 on Reply Card

Samsonite Beauty Thrives on Travel..

Protected By Precision-Stamped Parts

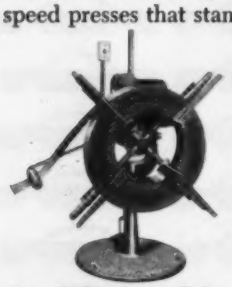


From *LITTELL*-Equipped Press Rooms



Samsonite—the world's most travelled luggage—gets durable beauty and extra strength from a modern stamping operation made more efficient by Littell Coil Handling Equipment. Littell Reels unwind coil stock for high speed presses that stamp out corner and shoulder plates, handle and lock plates and other reinforcing parts. Littell Scrap Winders pull and re-wind skeleton material from the press. A "308" Littell Straightener removes curvature from the ⅛" thick steel coil stock used for rugged Samsonite lock catches.

Samsonite is, in brief, another of the distinguished firms whose production men have found Littell Coil Handling Equipment saves time, work and costs.



No. 3-G—Motor Driven Automatic Centering Reel and Scrap Winder.

"Whether you stamp large or small parts, simple or complex pieces," says COILY. "Look to *LITTELL* For The Best."

F. J. LITTELL MACHINE CO.

Ask for Reel Catalog Series D

4105 N. RAVENSWOOD AVE., CHICAGO 13, Ill.

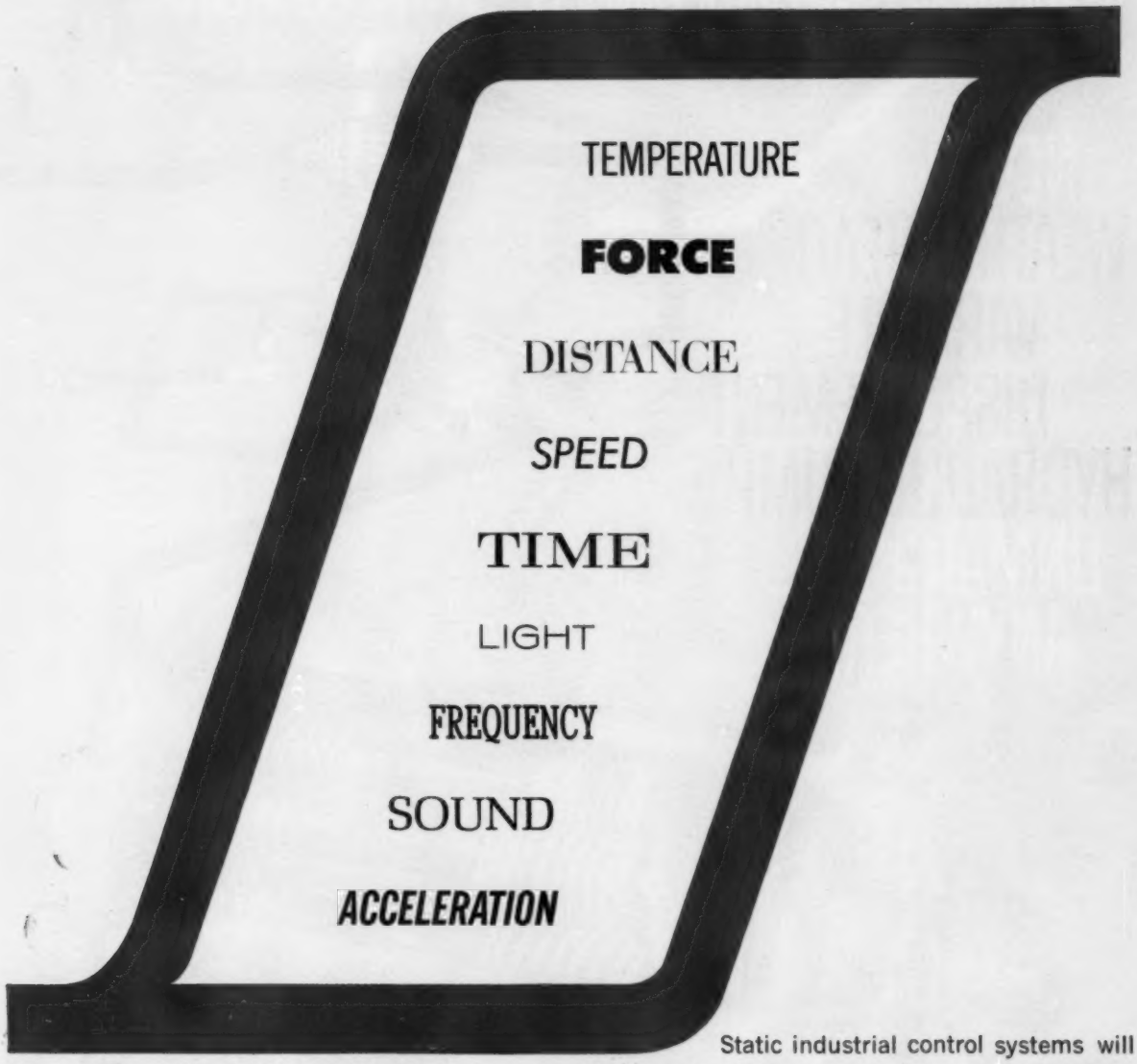
PORTABLE INSTRUMENT pinpoints hydraulic system trouble in a matter of minutes. The unit, which can be used in any position, includes a load-valve and gages for flow, pressure, and temperature. With the instrument installed on a piece of equipment, hydraulic troubles show up as a drop-off in flow, as working pressure is developed with the load valve. Trouble is then traced to the troublesome pump, valve, or cylinder by taking flow, pressure, and temperature readings on various sections of the circuit. Device was developed by Schroeder Brothers Corp.

engineer for Rundel Electric Co. . . . **Jack C. Horth** named chief engineer of the Woodworking Machinery Div., Yates-American. . . . **R. W. Ostermayer Jr.** appointed executive vice president of Pennsylvania Industrial Chemical Corp. . . . **Richard H. Wilcox** named assistant to the president at P. R. Mallory & Co. Inc. . . . **Galen Miller** elected president of Towmotor Corp. . . . **Thomas M. Goike** named chief engineer of General Kinetics Corp. . . . **Daniel S. Cvacho** promoted to director of packaging engineering for Reynolds Metals Co. . . . **Charles J. Randolph Jr.** appointed engineering manager of the Chemical Div., United Engineers & Constructors Inc. . . . **Malcolm Ehlers** named industrial engineering manager of Perkin Electronics Corp. . . . **Henry B. Tillotson** joined the Data Systems Div., Telex Inc. as director of manufacturing. . . . **Paul W. Larsen** named president of Information Retrieval Corp.

SPOTLIGHTING PLANTS

Grieder Industries Inc. has merged into **Pines Engineering Co. Inc.** which will now produce a line of bending and end finishing machines, tube cut-off machines, ma-

Circle 670 on Reply Card



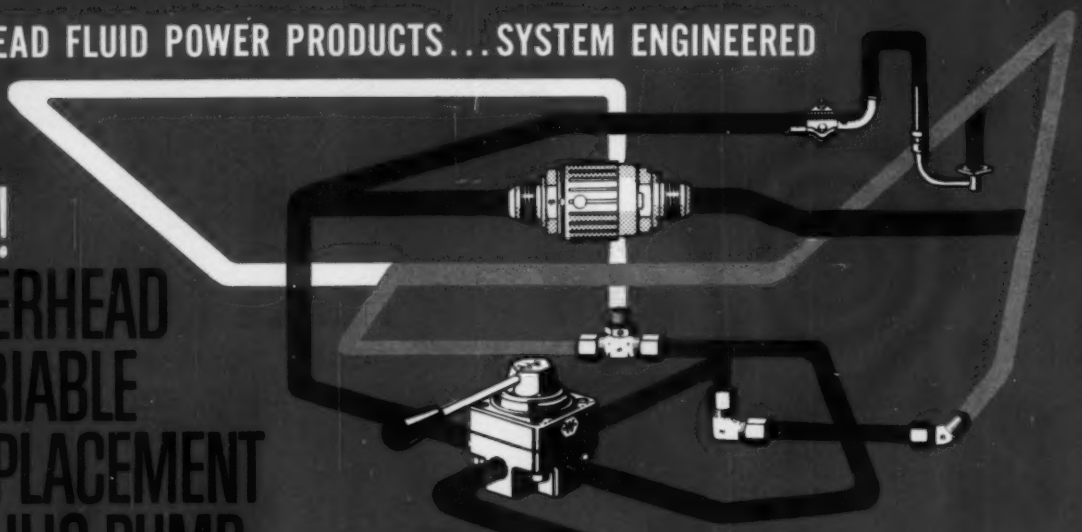
Static industrial control systems will regulate virtually anything that is controllable — and under normal operation these *magnetic* systems will never break down, wear out or need servicing. Temperature (with precision to ±1/4°F at 2200°), position (with logic involving *and, or, not, memory* and *time delay*), speed, force, light, sound, acceleration, frequency, distance, field strength and pressure are but a few. ■ One manufacturer has replaced a vacuum tube-mechanical relay system on his high-speed assembly lines. Reason: it broke down every three weeks. The replacement magnetic static control system has now gone through 26,000,000 consecutive cycles without fault. ■ The symbol above, the magnetic hysteresis loop, , may encompass some of your control problems which are solvable at a lower overall cost. May we discuss this with you? Magnetics Inc., Department **A-93,** Butler, Pennsylvania.

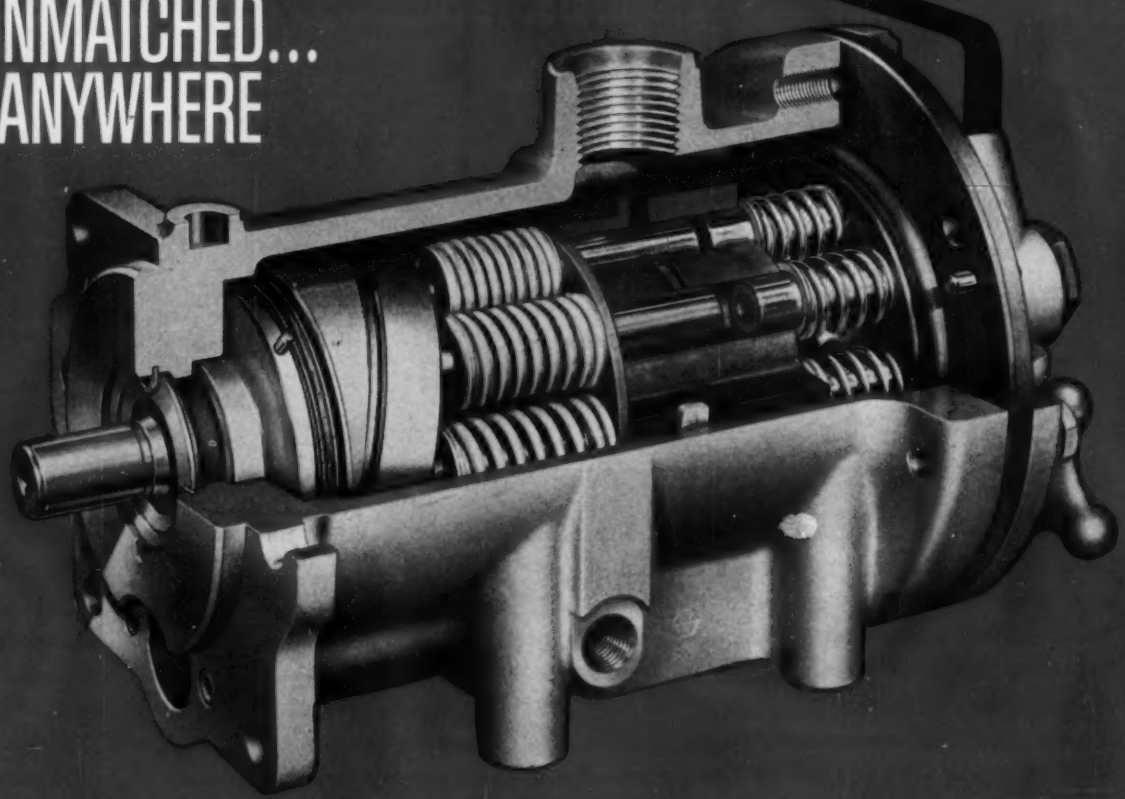
INDUSTRIAL CONTROL EQUIPMENT

MAGNETICS inc.®

WEATHERHEAD FLUID POWER PRODUCTS... SYSTEM ENGINEERED

NEW! WEATHERHEAD VARIABLE DISPLACEMENT HYDRAULIC PUMP UNMATCHED... ANYWHERE





The new WO7 pump gives economy and performance advantages unmatched in high pressure, fluid power system applications. No other mass-produced, variable displacement hydraulic pump can now offer *all* these benefits:

INSTANT RESPONSE . . . hydraulically balanced, direct cylinder block actuation at lower power level without linkages.

PEAK EFFICIENCY . . . only two rotating parts; side loads on pistons minimized.

CONTROL VERSATILITY . . . pumping forces virtually eliminated from the displacement changing mechanism.

HIGH TEMPERATURE CAPABILITY . . . unique piston actuation permits fluids of low lubricity.

PUMP ECONOMY . . . size and weight are adaptable to a variety of applications; top reliability assured with no selective fits.

Pressure compensation control is provided as standard and integral part of the pump in adjustable pressure ranges from 250 psi to 3000 psi.

The WO7 pump incorporates J.I.C., S.A.E. and A.N.D. design requirements for industrial and mobile applications; meets stringent requirements of military specifications. Spline or keyway shafts are available.

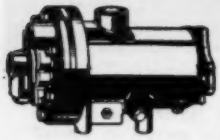
Application and design data are available from your nearby Weatherhead sales engineer. Direct inquiries to:

THE WEATHERHEAD COMPANY
HYDRAULICS AND PNEUMATICS
300 EAST 131st STREET • CLEVELAND 8, OHIO

Circle 672 on Reply Card

WEATHERHEAD
HYDRAULIC POWER
Components

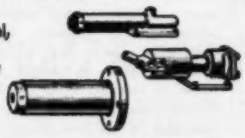
VARIABLE DISPLACEMENT PUMPS



Meet J.I.C., S.A.E., and M.S. standards. Pressures to 3000 psi

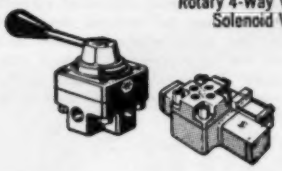
PUMP CONTROLS

Pressure Control, Automatic (Constant) Flow Control, Manual Displacement Control



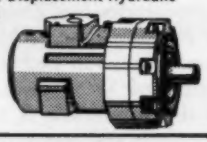
DIRECTIONAL CONTROLS

Rotary 4-Way Valves
Solenoid Valves



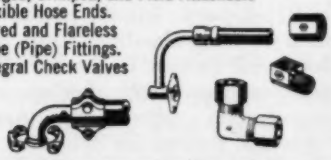
HYDRAULIC DRIVES

Fixed Displacement Hydraulic Motors, Reversible Variable Displacement Hydraulic Motors (Integrated Torque and Speed Control)



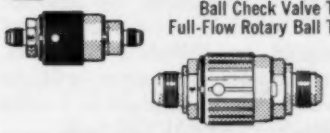
HIGH PRESSURE HOSE AND FITTINGS

Swaged, Crimped, and Field-Attachable Flexible Hose Ends. Flared and Flareless Tube (Pipe) Fittings. Integral Check Valves



SELF-SEALING COUPLINGS

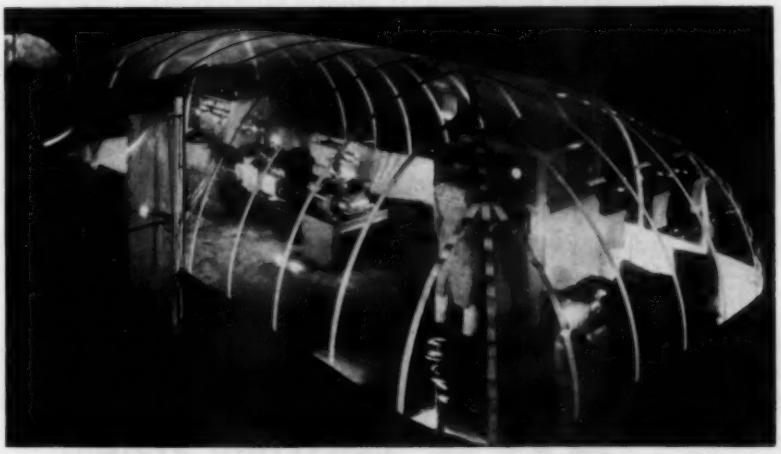
Ball Check Valve Type
Full-Flow Rotary Ball Type



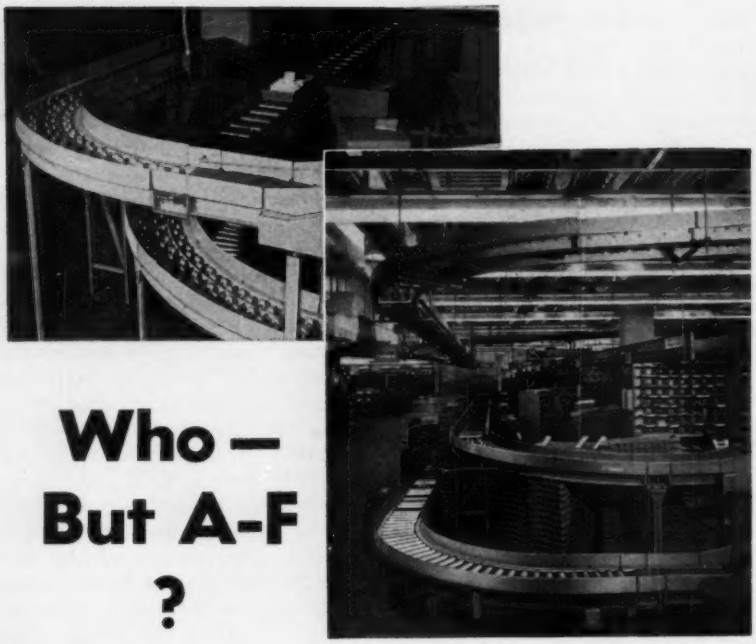
THE WEATHERHEAD CO.
300 EAST 131 ST. • CLEVELAND 8, OHIO
Distributors in all major markets

Circle 673 on Reply Card

terial handling equipment, and special machinery. . . . **AMP Inc.** has formed a new division to produce multiple-conductor connectors. Products of the new division, to be called Multicon Division, will include pin and socket type connectors, printed circuit board connectors, and tape cable connectors. . . . **Bowmar Instrument Corp.** and **Technology Instrument Corp.** have agreed to merge the two companies, subject to approval of the stockholders. Under the terms of the merger, one share of Bowmar stock will be exchanged for each 3.3 shares of TIC stock. Bowmar will be the surviving corporation. . . . **Beckman Instruments Inc.** has acquired the assets and operations of Offner Electronics Inc., for 58,823 shares of Beckman common stock. Offner, manufacturer of direct-writing oscillographs, and dc amplifiers, will become a division of Beckman. . . . **Champlain-Zapata Plastics Machinery Inc.** is the name of a new company formed to supply equipment using an advanced process for molding expandable polystyrene. Offices and manufacturing facilities will be in Caldwell, N. J. . . . **Computer Control Co. Inc.** has acquired Dychro Corp., manufacturer of precision optical shaft-angle encoders. Dychro will operate as a separate department and will occupy its present quarters in Wellesley, Mass. . . . **General Dynamics Corp.** has formed a new division, General Dynamics/Telecommunication. The new division, with headquarters in Rochester, N. Y., will produce the Stromberg-Carlson line of telephone equipment for the independent telephone industry. . . . **McKay Machine Co.** has been licensed to manufacture lines of metal processing equipment formerly manufactured by the Wean Equipment Corp. McKay will continue to manufacture their own products also. . . . **Datapulse Inc.** is the name of a new company formed to develop and manufacture a line of data simulation equipment, digital communication equipment, and pulse test equipment. Headquarters for the new company will be in Inglewood, Calif. . . . **General Electric Co.** has installed a series of rolling mills in its new plant in Euclid, Ohio to expand the company's capability for certain refractory metal production in wide sheet form. The first hot rolling mill is capable of producing a 24-inch wide tungsten sheet and plate in thicknesses of 0.500 to 0.150 inch. . . . **Barnes Engineering Co.** has acquired Connecticut Instrument Corp., manufacturer of accessories for the infrared spectrometer. Connecticut Instrument will become a subsidiary of Barnes. . . . **United Electro Dynamics Inc.** has formed a new division to expand in the development and manufacture of industrial communication and control equipment. Name of the new division will be United Industrial



PLASTIC BUBBLE structure is used by R. K. LeBlond Machine Tool Co. to provide ideal conditions for bringing into balance the operating characteristics of its tape-turn lathes and their tape control systems. The bubble, held up by air pressure, has a 10-ton air conditioner which can maintain temperature within 5F of setting at a time when shop temperature has varied as much as 25F. It is attached to the floor by simple pipe cleats and can be readily moved to another machine location.



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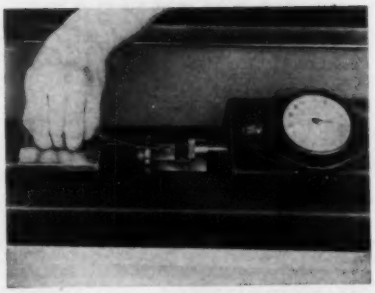

TERMINAL PULL TESTER is designed to check the tensile strength of crimped wire terminations and ensure low electrical resistance of solderless electrical connections in data processing equipment. Quality control engineers at Sylvania Electric Products Inc. use the tester to check the performance of crimping tools. A sample crimped terminal is inserted in a terminal holding fixture provided on a force gage, and the wire leads are placed between a pair of jaws extending from an air motor. When the air motor is actuated the jaws close and pull the wire at a predetermined, controlled rate-of-speed. When the crimped connection fails, the gage pointer registers and holds the force reading at failure. Instrument is manufactured by Hunter Spring Co., Div., American Machine & Metals Inc.

Systems Division. Headquarters and manufacturing facilities will be in Monterey Park, Calif. . . . **Wyle Laboratories** has acquired the stock of Ransom Research Inc. and Ransom Systems in exchange for 30,000 shares of Wyle stock. Prime aim of this acquisition is to extend data handling and computing techniques into many relatively undeveloped industrial fields. . . . **Transitel International Corp.** is the name of a new company jointly owned by Baldwin-Lima-Hamilton Corp. and Industrial Process Engineers. The new company will develop and manufacture telemetering equipment and systems for industrial applications. Headquarters will be in Paramus, N. J. . . . **Textile Machine Works** has purchased the Schooler Mfg. Co. Inc., manufacturer of wrapping and banding machines. The Schooler operations will be moved to the main plant of Textile in Reading, Pa.

MEETINGS & EVENTS

Nov. 1-2—
American Society of Mechanical Engineers. Textile Engineering Di-

Circle 674 on Reply Card

Circle 675 on Reply Card→

WE'RE PUTTING OUR MONEY WHERE OUR MOUTH IS!

WITH A 90-DAY MONEY-BACK GUARANTEE ON THE NEW PRATT & WHITNEY TAPE-O-MATIC DRILL

$8,595

1½ HP. Big 30" x 20" table.
Simultaneous positioning of both axes.
(3 HP. optional at extra cost.)

NOW! FOR THE FIRST TIME A NUMERICALLY CONTROLLED DRILL FOR ONLY $8,595 GUARANTEED TO REDUCE YOUR DRILLING COSTS

At last . . . a drill with the finest, transistorized, numerical-control system available for only $8,595 . . . because P&W brings mass production to the machine tool industry for the first time . . . yet maintains the 100-year tradition of P&W quality.

The TAPE-O-MATIC enables **you** to benefit from numerical control . . . to gain a vitally-needed, important competitive edge.

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1 90-DAY, MONEY-BACK GUARANTEE. If by 90 days after purchase, this drill has not reduced your drilling costs, return it for refund, less transportation costs.

2 5-YEAR WARRANTY. We fully warrant the TAPE-O-MATIC drill against defective parts and workmanship for 5 years from date of purchase.

3 UNIQUE TERMS. You can buy TAPE-O-MATIC using our exclusive Trade-in Plan. You can purchase the drill outright, lease it, or lease it with option to buy. ONE PER CENT CASH DISCOUNT FOR PAYMENT IN 10 DAYS.

Call collect . . . your local Pratt & Whitney representative, now! Or write to: Paul N. Stanton, Vice President Marketing; Pratt & Whitney Co., Inc.; Charter Oak Blvd.; West Hartford, Conn.

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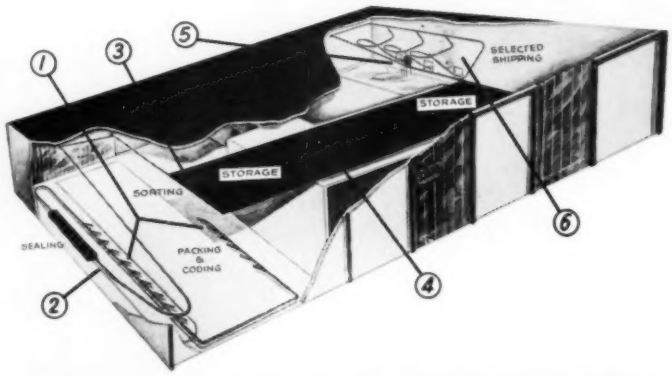
Machine Tools / Cutting Tools / Gages

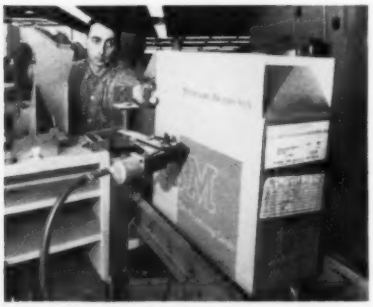
HEADQUARTERS FOR AMERICA'S WAR AGAINST OBSOLESCENCE

REPORT ON
CUTTING COSTS WITH CONVEYORS

How a Standard Conveyor custom-engineered system at IBM provides · simple electronic sorting · space-saving gravity storage · push-button order filling · one-man operation

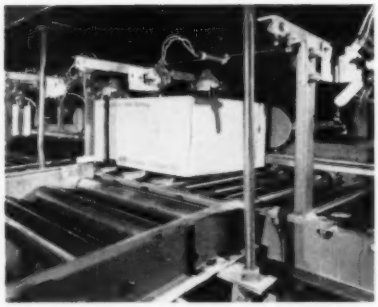
IBM's punched card plant at Concord, Mass. turns out hundreds of millions of cards per year for its New England customers. The mere physical handling of this massive volume is a problem in itself—and it becomes even trickier because each order is unique, usable only by one customer. Complicating the problem, each carton of 10,000 cards is outwardly identical, except for the shipping label. Here's how Standard Conveyor's *System Specialists* helped IBM work out a simple mechanized system to solve the intricate sorting and storing problem.





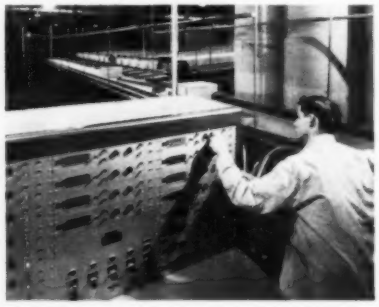
1 At card manufacturing machine station, each full carton is automatically coded by a brass staple as it enters conveyor system. Staple position determines to which storage line carton will go. Staple does not penetrate inside of carton.

2 Boxes from various stations, representing different customer orders, are intermixed on main conveyor line. After being closed and sealed they are turned on their sides before being routed to sorting and storage conveyors.



3 On sorting conveyor, position of coding staple, now on top, is sensed by electrical brass-fingered reader. If reader contacts staple, a retractable stop pops up and air actuated ram pushes carton into correct storage line.

4 Six of the 16 ceiling-hung storage lines as seen from the sorting area. Each customer order is now in one line and may consist of any number of cartons.



5 Shipping clerk at order filling console knows from his shipping card where orders are stored, how many cartons each order contains, and which carrier gets which order. When truck arrives, clerk selects order desired—rest is automatic.

6 Cartons enter shipping room from storage lines at left. Shipping clerk also operates electrical diverters from console to route each order into one of four chutes. Thus, one man controls the entire sorting and storing system.

Standard Conveyor COMPANY

303-L Second St., North St. Paul 9, Minn.

Specialists in the System Concept of Conveying. Fully staffed with professional personnel who are ready to help you envisage, engineer and execute a master plan to cut material handling costs. Sales engineering offices in more than 50 cities . . . consult your telephone book Yellow Pages under "Conveyors".

vision Conference will discuss Automation and its Potential for the Textile Industry. To be held at the Little Theatre, Kresge Auditorium, Massachusetts Institute of Technology, Cambridge, Mass. Additional information available from society headquarters, 345 East 47th St., New York 17, N. Y.

Nov. 1-3—

Industrial Management Society. Industrial engineering and management clinic to be held at the Pick-Congress Hotel, Chicago. More details available from society headquarters, 330 South Wells St., Chicago 6, Ill.

Nov. 6-8—

Technical Conference on Non-Linear Magnetics. Cosponsored by American Institute of Electrical Engineers and Institute of Radio Engineers. To be held Statler Hilton Hotel, Los Angeles. Additional information available from IRE headquarters, 1 East 79th St., New York 21, N. Y.

Nov. 7-10—

Packaging Machinery Manufacturers Institute Show. Conference and exhibit to be held Cobo Hall, Detroit. Additional information available from Hanson & Shea Inc., One Gateway Center, Pittsburgh 22, Pa.

Nov. 8-9—

American Society of Tool and Manufacturing Engineers. Seminar on prototype and short run tooling methods to be held Belmont Plaza, New York. Information available

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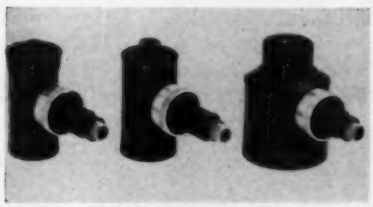

LOAD CELLS that are actuated by deflections as small as 0.001 to 0.005-inch have been designed by Force Controls Co. to control or detect compression or tension in a production setting. The minute deflections, acting on a special sensor unit, generate an electric impulse which triggers a plug-in relay controller. The cells have capacities ranging from 500-1000 to 75,000-500,000 pounds of force, and can sustain overloads up to four times their rated capacity.

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DEPENDABLE FLUID POWER with (AE) Hele-Shaw Hydraulic Pumps

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■ **INFINITELY VARIABLE DISPLACEMENT**

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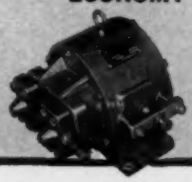

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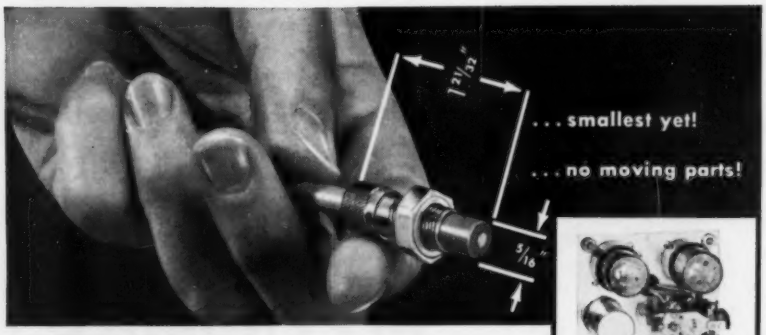

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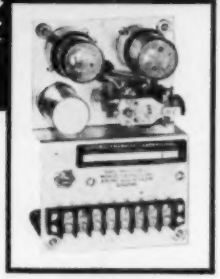

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Connecting cable

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Most complete line of Proximity Switches and Magnetic Transducers · Tachometers · DC Power Supplies

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At Randolph Mills...

A WAGNER® INDUSTRIAL RECORDING SYSTEM

helps maintain production line efficiency

Randolph Mills uses Tachographs to measure production efficiency and time. When one shift in finishing fell far behind production, a Tachograph showed that the wash range machine wasn't draining water fast enough . . . pinpointed the situation that needed correction.

Tachographs are precision recording devices that can be used anywhere the control of speed, time and measurement is essential to the quality of your products. They can help you determine production peaks and valleys, and non-productive time. Chances are, they can help increase your plant's efficiency. Mail coupon below for full information.

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W161-3

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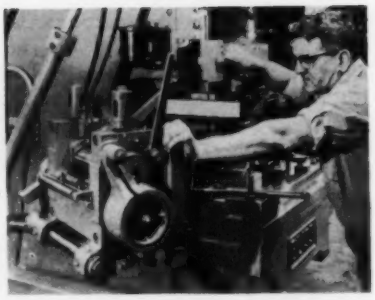

PORTABLE FEED, which makes a press adaptable to either single or continuous operation, is available on new presses from E. W. Bliss Co. It can be used as a conventional single roll feed for continuous feeding or by simply removing two bolts, it can be swung away from its normal position to permit single trip hand feeding. Switching the feed to a number of presses of the same or different tonnages is possible, but each press must be equipped with special mounting pads, pivot bracket, and throwblock to permit transfer of the feed from press to press.

from society headquarters, 10700 Puritan Ave., Detroit 38, Mich.

Nov. 9-13—

Society of Automotive Engineers. National fuels and lubricants meeting to be held Shamrock Hotel, Houston. Further details available from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Nov. 13-15—

Steel Founders' Society of America. Technical and operating conference to be held at Hotel Carter, Cleveland. Further information available from Bayless-Kerr Co., Hanna Bldg., Cleveland 15, Ohio.

Nov. 13-16—

Conference on Magnetism & Magnetic Materials. Cosponsored by Institute of Radio Engineers, American Institute of Electrical Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers, American Institute of Physics, and Office of Naval Research. To be held Hotel Westward Ho, Phoenix. More details available from IRE headquarters, 1 East 79th St., New York 21, N. Y.

Nov. 15-17—

Eastern Analytical Symposium. Cosponsored by American Chemical Society, Society for Applied Spectroscopy, and Metropolitan Micro-

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designs out the extras

Last year, a certain manufacturer used a shipping container with 21 interior pieces. Although it was effective, assembly costs were high, so the container was presented to Gaylord designers for revision.

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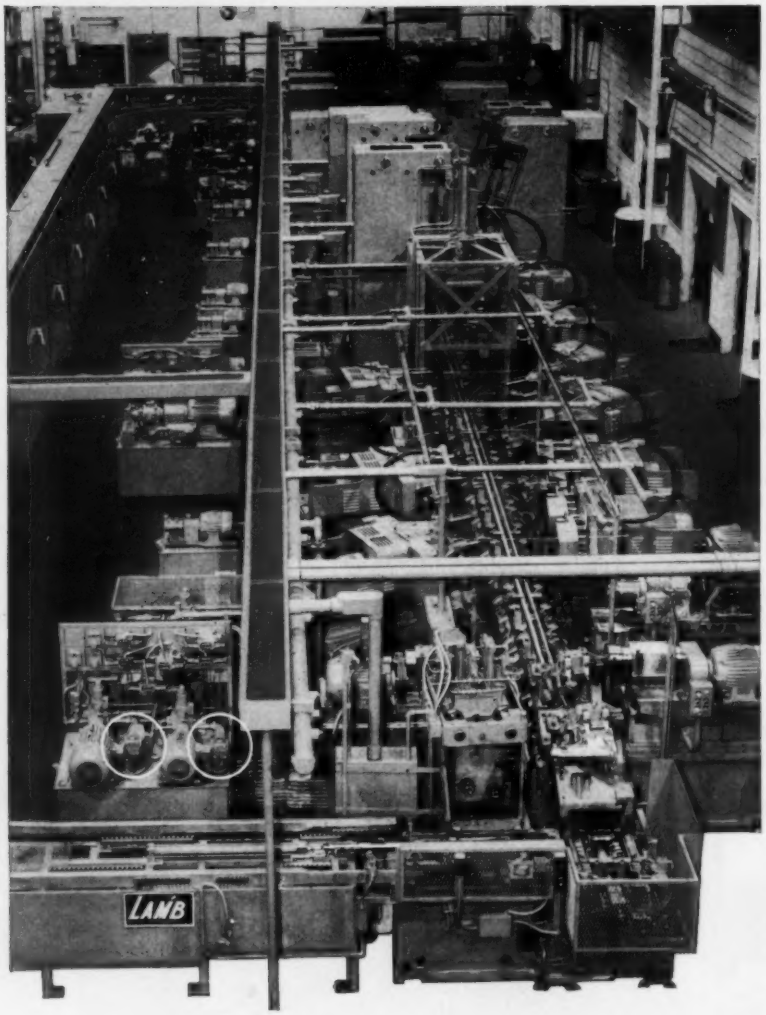

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with TELL TALE* Filters

Circled in the Lamb transfer machine are just two of the dozens of TELL TALE filters there. They are there because they help the precise hydraulic movements stay precise. You'd specify TELL TALE too, if you knew what they do. To find out, ask for our catalog.

**TELL TALE is a registered trademark of the Rosaen Filter Co. It signifies a line of filters that tell when they need cleaning, are easy to clean, and will never starve a pump. They are unique. Ask for our list of users.*

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TELL TALE filters are available from Rosaen distributors and Vickers warehouses everywhere.

chemical Society. Symposium and instrument exhibit to be held Statler Hilton Hotel, New York. Additional information available from Dr. Arnold Mowitz, Interchemical Corp., 432 W. 45th St., New York 36, N. Y.

Nov. 18—

Society of Carbide Engineers. Annual meeting to be held Belmont Plaza Hotel, New York. Details available from society headquarters, P. O. Box 45, Newington 11, Conn.

Nov. 26-Dec. 1—

American Society of Mechanical Engineers. Annual winter meeting to be held Statler Hilton Hotel, New York. Additional information available from society headquarters, 345 East 47th St., New York 17, N. Y.

Nov. 27-Dec. 1—

Exposition of Chemical Industries. Biennial review of newly developed products and processes for the chemical industry will be held at the New York Coliseum, New York. Further details available from International Exposition Co., 480 Lexington Ave., New York 17, N. Y.

Dec. 6-7—

American Society of Tool and Manufacturing Engineers. Seminar on electric machining and forming (electro metal removal) to be held Statler Hilton Hotel, Hartford. Details are available from society headquarters, 10700 Puritan Ave., Detroit 38, Mich.

"Just keep your feet off the floor 'til I get more wire."

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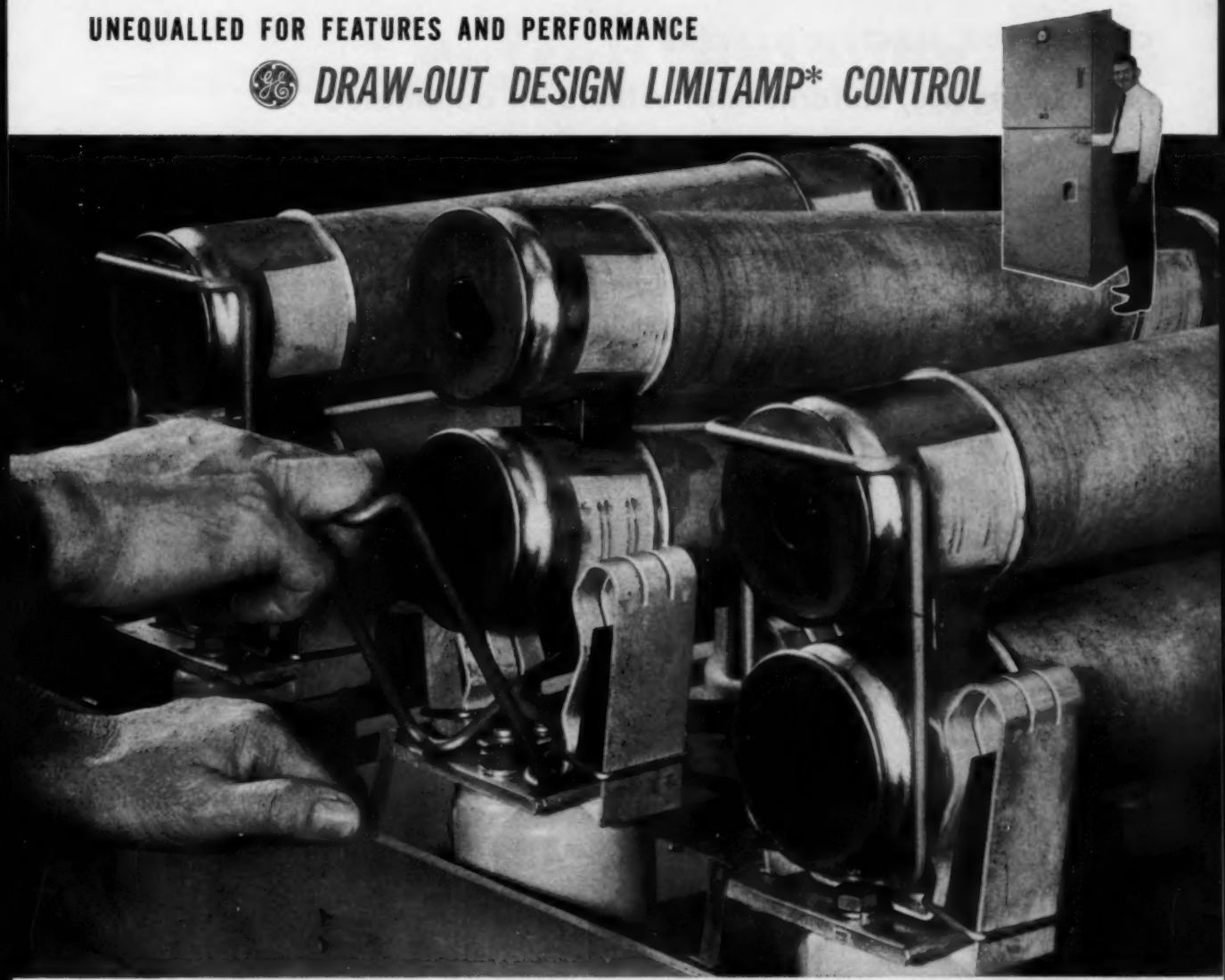
UNEQUALLED FOR FEATURES AND PERFORMANCE

DRAW-OUT DESIGN LIMITAMP* CONTROL



INTERRUPTS IN 1/2 CYCLE

...protection when you need it—with Limitamp control

Here is performance you can count on ... to start, stop, and protect your motor under *your* environmental conditions!

General Electric's draw-out Limitamp control, rated 2300- to 4600-volts for a-c motors up to 3000 hp, interrupts in the first ½ cycle. Current is limited in the first ¼ cycle. EJ-2 fuses—the standard of excellence—give you this dependable short-circuit protection.

Performance of the draw-out contactor is outstanding under all load conditions—from small motors running light to large motors at "locked rotor." A new blow-out structure and an improved arc chute with superior extinguishing action provides this improved performance. What's more, the new Limitamp contactor meets a 60-kv base impulse level.

Complete design coordination and exhaustive testing in General Electric's high voltage laboratories of bus, cable, current transformers, contactors, fuses, insulators, and overload relays means top protection for men and equipment!

Ask your G-E sales representative about other advanced-design operation, installation, and maintenance features of new Limitamp control. Or, write today to Section 783-26, General Electric Company, Schenectady, New York for descriptive Bulletin GEA-6893.

Industry Control Dept., Salem, Va.

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Progress Is Our Most Important Product

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CHROMALOX ELECTRIC HEATERS

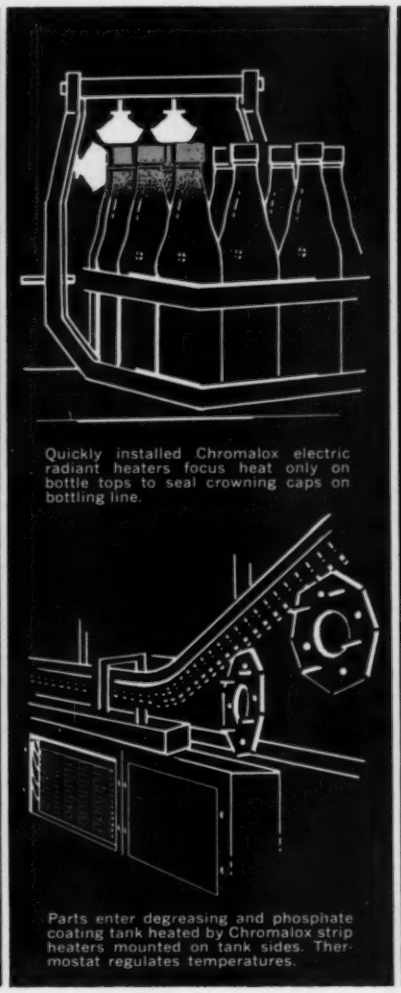
provide precise, uniform heat centers on automated operations, regardless of product size or shape

Precise control, from 4 to 100% of output, can be made an integral part of a Chromalox far-infrared heating installation. Temperatures are "dialed."

Compact far-infrared units interlock into self-forming ovens. Single or double heat sources in lengths from 24" to 185", many wattages.

Straight lengths, formed or "finned" Chromalox strip heaters in 50 to 6,000 W; ¾", 1", 1½" widths; 5" to 96" lengths.

Chromalox immersion heaters — for heating water, oil and other liquids. 3" to 14" pipe flanges— with or without built-in thermostats.



Quickly installed Chromalox electric radiant heaters focus heat only on bottle tops to seal crowning caps on bottling line.

Parts enter degreasing and phosphate coating tank heated by Chromalox strip heaters mounted on tank sides. Thermostat regulates temperatures.

Chromalox flange-type immersion heaters, mounted in cleaning tanks, thermostatically control the chromic acid solution bath.

Chromalox far-infrared radiant heaters bake paint on pulley wheels. With input controllers, heat can be adjusted for heavy and light sections of wheel.

"3-zoned" oven, assembled from interlocking Chromalox radiant heaters, cuts baking time up to 500% due to faster heat absorption of far-infared.

Chromalox electric heating equipment can help you automate your production lines to cut costs, improve production and/or reduce rejects . . . as well as solve many of the critical heating problems encountered in line production. They are frequently used to boost existing heat-source temperatures. Among the Chromalox advantages are easy, low cost installation; dependable and economical operation; minimum attention and maintenance. Whatever your need for heat—whether for production-line or other processing applications—Chromalox electric heaters can provide exactly the heat source you require. Engineering assistance is available without obligation. Write, wire or phone.

FOR YOUR INFORMATION

Write for Catalog 60. It details uses for electric heat and describes thousands of types, sizes and ratings of Chromalox units.

EDWIN L. WIEGAND COMPANY

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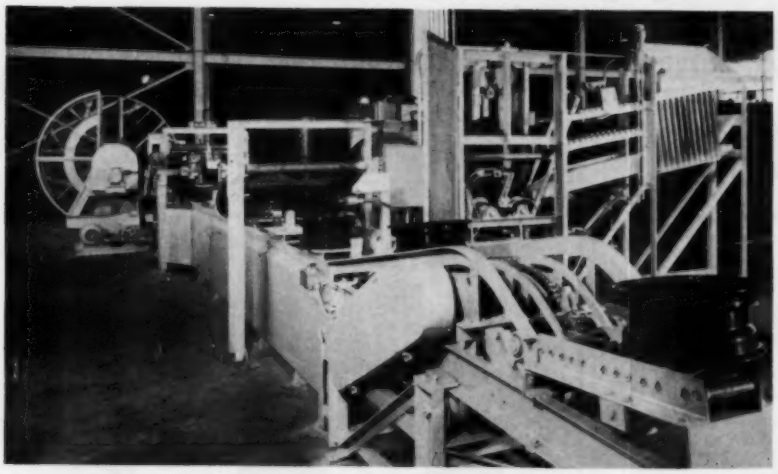
WI-24

CHROMALOX ELECTRIC HEAT

PROCESS COMFORT

By LEE D. MILLER, Associate Editor



Tire mounting and inflating lines of this type have recently been fabricated for European and Japanese manufacturers by Allied Steel and Conveyors. Rims enter from lower right on conveyor; tires from upper right. Tire beads are automatically soaped, and tires are mounted on the rims and inflated. The mounting head is self-adjusting so that different sizes of wheels and tires can be assembled without shutdowns for changeovers.

Expanding Horizons

COMPACT cars may be receiving a lion's share of current interest (a small lion of course), but that shouldn't be taken as meaning that autodom's horizons are all contracting. There are some interesting expansions being reported. Some of them, in fact, are being applied to small car production.

Stretched to Shape

A manufacturing development for automotive sheet metal parts is one such. Wallace Expanding Machines Inc. has announced the building of an expanding type machine to produce front fenders and outer door panels for the English Mini-Car. Tooling for roof panels, inner and outer deck lids, and inner door panels is also planned.

A length of stock to be expanded is either rolled into a cylinder or folded into a rectangular sleeve. The ends are then seam welded to form a continuous loop. For the forming operation, this loop is positioned over a cluster of punches. The punches are arranged around a vertical axis in such a manner that they can be simultaneously moved radially out from that axis. Mating dies are positioned outside the loop for engagement with the punches. As the punches are driven radially outward, they stretch the blank and form it against the dies.

A major feature of the system is the elimination of conventional blank holders and the excess stock which they require. In this system of expansion forming, the blank holder function is performed for one part by the two adjacent parts. In fact, the stock area required for any one part can be slightly less than the area of the punch face for that part. The press shop greenhorn who is sent for a blank stretcher might put the shoe on the other foot by bringing this machine to the attention of the pranksters.

In an automated system a setup of this type would be expected to process four-part blanks at a rate of 300 per hour, or a production of 1200 parts per hour. Similar expanders have been used for several years in the appliance field. This automotive application adds another example to the old bees and flowers story of cross-pollination.

Also over the Waves

Expanders aren't the only firms expanding into overseas automotive operations. F. Jos. Lamb Co. recently shipped elements of 850 tons of equipment designed for manufacturing automotive engine and transmission components in Germany. This equipment represents their largest export order to date and inaugurates a planned expansion into world trade and foreign representation.

Allied Steel and Conveyors has been shipping some equipment abroad for expansions that are literally inflationary. As illustrated by the lead photograph, they have been building equipment that automatically mounts tires on rims, inflates the tires to preset level, and delivers the units to a final assembly line. They have recently built tire mounting and inflating equipment of this type for European and Japanese manufacturers.

Over the last several years, such tire mounting equipment has been installed in assembly plants of major automobile and truck manufacturers in the United States. It was assumed that sales for this specialized equipment would diminish until there was renewed demand for replacement equipment here or some far-in-the-future buildup of demand abroad. However, there has recently been a growing interest in such tire mounters and specialized conveyor equipment overseas.

These are interesting signs from over the waters. Progressive application of more advanced production equipment in foreign plants will make them stronger contenders

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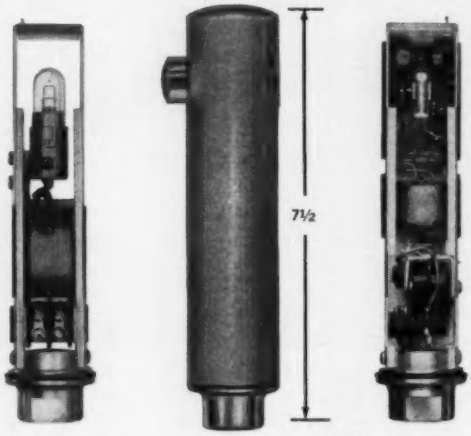

Light Source Type 40 CE 1 — On-Off Control Type 22 LB 5

Ingenious, extremely compact easy-to-install design. Ideal for conveyor use and many other jobs such as counting, sensing, positioning, limit switch replacement. On-off and adjustable time delay models available. Priced for tight budgets. No vacuum tubes mean no heat, practically no maintenance. Weathertight housing. Speed to 1200 operations per min. Ranges to 20 ft.

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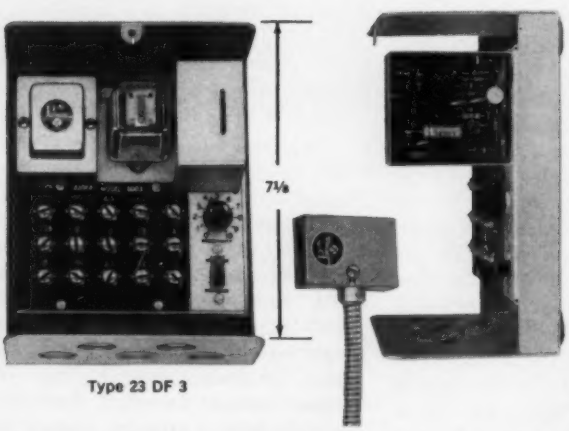

Type 23 DF 3

A better control answer for packaging machinery registration, printing register control, precise cut-off, coding, sorting and high-speed sensing of small objects. Responds to 1 millisecond light or dark pulse. Detects light changes as low as 5%. Operates from reflected light or transmitted light. Scanner, little larger than cigarette lighter, covers full range of color combinations.

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Weatherproof. Employs infrared-sensitive cell and modulated invisible beam to provide exceptional performance up to 1000 ft. Receiver responds to light interruptions as short as 5 milliseconds. Detects heated objects as low as 350°F. Plug-in chassis. A success in paint spray booths under high ambient light. Problem solver in foundries. Fine for intrusion alarms, automatic door and vehicle control. What is your tough application?

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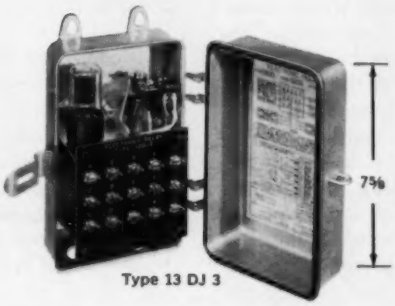
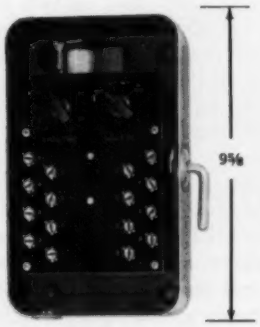


Type 13 DJ 3



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in the world market. It will mean a reduction in one edge we may have had over them in some areas. This will surely serve as a factor to increase the pressure here for even better performance of the manufacturing engineering function.

In the long run it could, however, serve to expand the marketability of our own automotive products. If better production methods lead to higher standards of living abroad, sales of our products could improve if our prices do not rise as rapidly as theirs.

Facility for the Needs

In the nearby time, the need for better production methods and facilities here appears to be the most likely result to be expected. Currently Allis-Chalmers Mfg. Co. is taking a step which will help them meet that need. They have started operations in their new Harvey, Ill., engine plant. The new plant provides a flexible production facility to produce more than 130 variations of gasoline, diesel, butane, and natural gas engines for industrial, farm, and construction machinery.

More than 600 machine tools have been installed in the new plant. They include many custom machines arranged in six major conveyorized lines. The new machines also include three tape-controlled units. Two of them are used to handle the many variations of intake and exhaust manifolds. A tape is prepared to program the automatic drilling and tapping of each style of manifold. The third tape-controlled machine is used to drill and bore the varieties of flywheels required. This unit has four separate heads.

Three of the major lines are for block machining and three for head machining. These lines are semi-automatic, with movement of heads and blocks on roller conveyors from machine to machine. After the machines are manually loaded and started, they cycle automatically and discharge the workpieces.

Flexibility was a prime goal for each machine because of the wide range of workpieces to be machined on each line. Planning and design with that goal in mind makes it possible to make model change-overs in about one hour per machine. Planning of the plant layout provided a straight line type production system in which material is received at one end of the building and assembled engines come off the lines at the other end.

Four assembly lines handle the major engine production; and a fifth assembly line is used for electric power generating sets, marine engines, and special industrial engines. With a schedule calling for a favorable mix, these production lines can produce 150 to 200 engines per day.

Assembled engines are transferred to overhead power conveyors and moved to separate test areas for gasoline and diesel engines. Every engine is tested. Gasoline engines are hot tested on 20 free-running stands. Diesels are checked in 34 dynamometer test stands.

Computing circuits on each diesel test stand provide direct readout of horsepower. The readings at each station are automatically corrected by a signal from a central computing unit for such variables as barometric pressure and ambient temperature. The computing elements at the individual stands also compute specific fuel consumption based on fuel temperature, viscosity, engine speed, horsepower, and other factors.

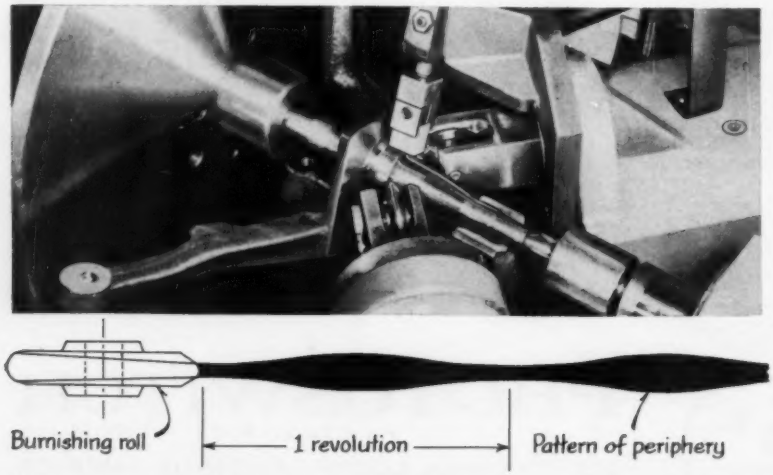
Chipless Finishing Expands

Production capabilities have also been expanded for chipless metal finishing at Ford Motor Co. They recently bought a special machine to roller burnish the radius where the spindle shaft projects from a front-wheel spindle. Working with their engineers, Michigan Tool Co. designed and built the machine to burnish the radius after the assemblies are ground.

The operator loads a front-wheel spindle into the machine and presses the cycle button. The machine spindle rotates and the two tool slides on the machine are moved in hydraulically to bring the burnishing rolls into contact with the work. The rollers automatically center themselves in the radius because they are mounted in such a manner that they are free to move axially as well as rotate. The rollers coldwork the fillet for 15 to 17 seconds, then the tool slides retract and the machine stops.

Design of the rollers is such that the point of contact between each roller and the workpiece automatically moves up and down the fillet as the work rotates. This continuous shifting of the contact point works the fillet surface evenly and prevents tool marks. Shifting of the contact point is obtained by use of rollers on which the peripheral contact surface has varying edge radii.

Simply the effect of an expanding and contracting roller width gives the roll burnishing technique expanding usefulness on the Ford horizon. Just goes to show—it doesn't have to be complicated to be automatic.



New machine built by Michigan Tool Co. roller burnishes front-wheel spindles. Design of tooling provides automatic centering of rollers on fillet and continuous sweep of roller contact over fillet surface. Sketch indicates the design of roll periphery that shifts the roll contact up and down the fillet.

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ASSURE:

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Post's *proven* electronic counters and control systems are in widespread use throughout industry. Serving such diverse needs as batch counting, measuring, sensing or machine control. Post electronic products are ideal production aids.

Note these examples of Post's broad line of Electronic Products . . .

COUNTERS

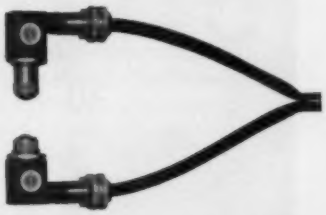
SD-1T Outmodes mechanical counters. Will operate at speeds up to 100 units per second. Single 'count' registers on visual totalizer as each 10th. item breaks beam. Note: 12 place tube available for counting dozens or gross lots.

P-5 Preset counting of any desired 'batch' — 1-100,000 units. Other models available for 10,000 or 1,000,000 range. Direct 'batch' readout on all models from totalizer . . . quantity less than 'batch' shown directly on tube face (s).

PW-5 PRESET Counter with BUILT-IN WARNING SYSTEM. Model shown will 'batch' count 1-100,000 units (inclusive) and warning selection dials may be set to energize a secondary control circuit, i.e., 'Batch' count desired 5000 . . . warning count desired 4900. When warning count reached, impulse may be given to flash light, operate solenoids for opening or closing feed gates, etc.

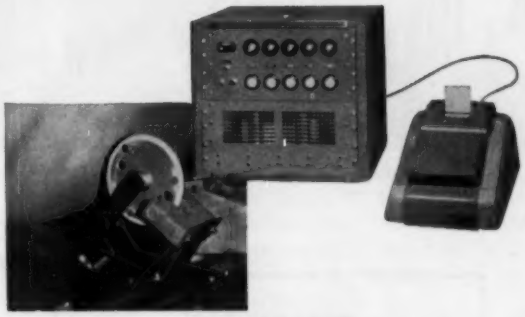
SENSING DEVICES

H-21-C A miniature, all purpose photohead. Ideal for limited space application. 'Head' not much longer than standard paper clip. Exciter lamp life 5000 hours. Utilizes photosensitive semi-conductor cell.



MH-2-P A new, compact magnetic switch in neat epoxy resin shell. . . . Magnetically operated as sensing device, the MH-2-P is capable of speeds up to 100 cycles per second — long life — no "bounce".

CONTROL SYSTEMS



LF-1A Lineal footage measurement, electronically . . . Capable of length measuring continuous production items, i.e., paper, wire, rope, ribbon, etc.
Features visual and printed readout.

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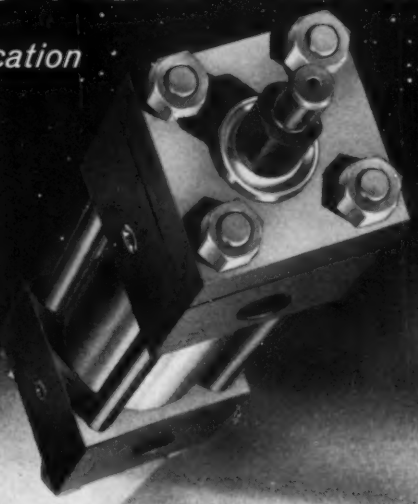

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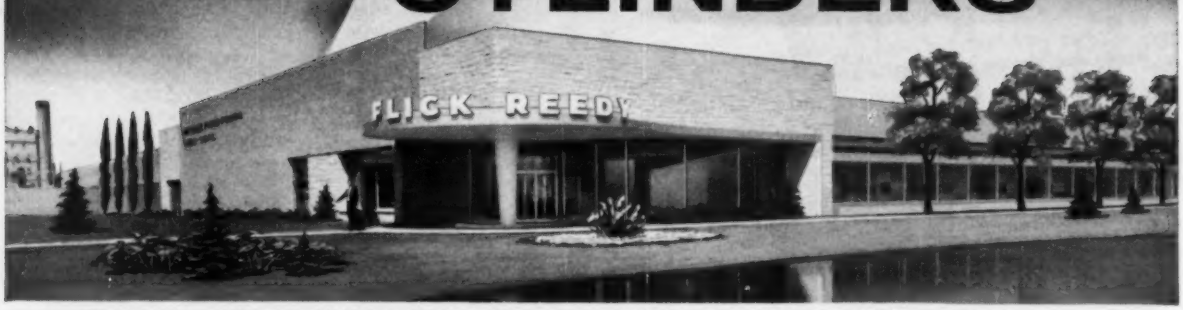

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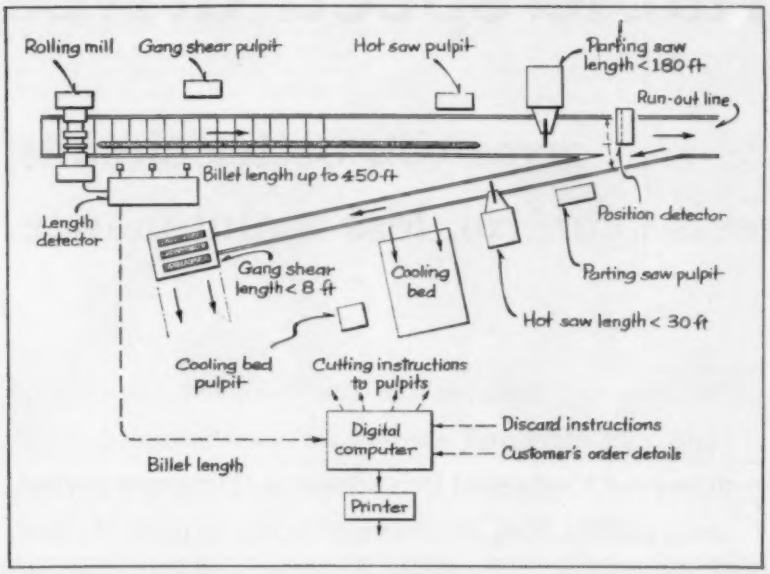

Information system using a digital computer provides data on optimum cutting lengths for steel billets in this portion of a British steel mill. Two variables—lengths of billets as-rolled and lengths ordered—are handled by the computer to determine the cutting program that will result in least waste. Cutting instructions are displayed on panels at four control locations.

Programmed Billet Cutting

RECENT application of an information system for optimizing billet cutoff is evidence that British steelmakers are aware of the improvements that can result from use of computers in production operations. The installation is in the Stockbridge Works of Samuel Fox & Co., a member firm of United Steel Co. Ltd., Sheffield.

The plant rolls steel billets in lengths up to 450 feet before cutting them to customers' requirements. Since the steel is largely made to order, the billets must be cut to produce minimum waste within the limits of customers' specifications and lengths finally rolled. A complicating factor is the layout of the mill (see illustration) which necessitates the use of cutting devices at two or three points.

Billet cutting involves four operations: First, the measurement of billet length; second, the calculation of optimum cutting points; third, the transmission and display of this information to saw and shear operators; and fourth, the recording of cutoff data for office purposes.

Several aspects of the problem suggested the use of a digital computing system. For example, computations must be made rapidly so that billets need not be held up on the track. And since a number of billets can be on the track at the same time, considerable capacity for the storage of information is required.

A joint study by Samuel Fox & Co. Ltd. and E-A Automation Systems Ltd. showed that there was ample economic justification for an information system including a digital computer to optimize the cutting of billets. Accordingly, a Panellit 609 information system which incorporates an Elliott 803 general-purpose computer was provided.

With the system, billet length is measured by a pulse-counting device that compensates automatically for wear on the mill rolls. Infrared-sensitive detectors are used which can sense the presence of billets that may have cooled down to 400 or 500 C because of delays at earlier rolling stages.

To program a cutting operation, a foreman enters details of a customer order on a console. The order may specify a fixed length, a limited continuous range of lengths, or a range of lengths consisting of a series of steps. The computer then calculates the optimum cutting points to satisfy the length requirements in light of mill operating conditions. In the computation, allowance is made for the statistical variability of the stops at each saw and shear. Provision is also made to supply required test pieces. Such calculations take less than a second, and are normally stored in the computer's memory until called for by an operator.

At each control pulpit, an operator has a display panel on which information relating to a billet is shown when a *Demand* pushbutton is operated. Checks are provided in the system to ensure that the information displayed is that for the billet in cutting position, and that the system is operating normally. A data printer supplies necessary accounting records.

A feature of the system is that changes in operating conditions can be accommodated easily. The manual operations retained in the present system can be replaced with

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. . . gives you better circuits, precise control, less maintenance.

Reliance has produced the first complete line of solid state regulators and exciters for variable speed (V*S) drives and Engineered Drive Systems. These new devices, using power silicon rectifiers and diodes in place of tubes, achieve precise motor control, 1/10% regulation at base speed, with response times up to twice as fast as tube-type regulators. Here is a major advance in variable speed control, and a major advantage for the industrial user. Reliance Drives with these new regulators are now available to you in 1 to 1500 horsepower.

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The pictures on the facing page tell the story.

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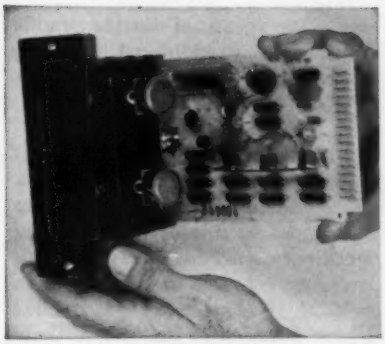
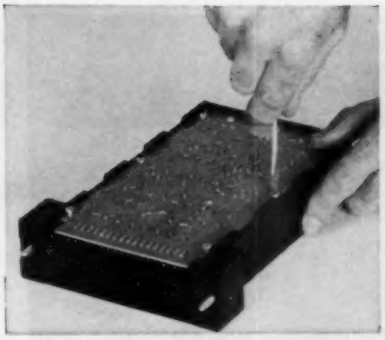
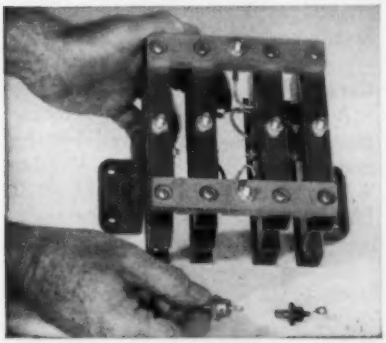


1. Heart of the system is new "Cardpak" control circuit, with transistors, capacitors and resistors to amplify feed-back signals.

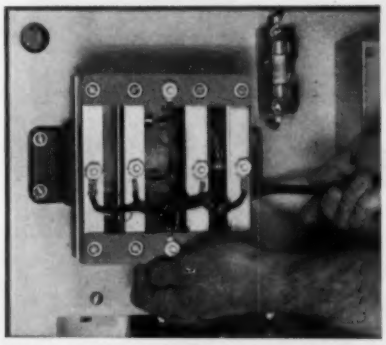


2. Each plug-in "Cardpak" module is a complete control circuit...can be quickly checked and easily replaced, if ever necessary.

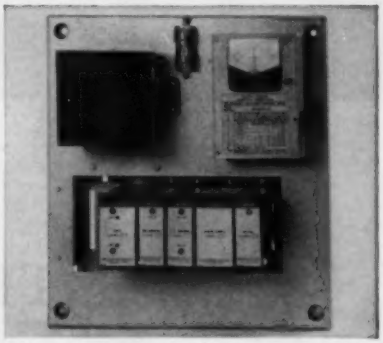
3. Each V★S Drive control system is tailored to your specific job . . . with "Cardpak "circuits pre-engineered for reliability, fast delivery.



4. Power silicon controlled rectifiers and diodes, instead of tubes, are among the most reliable components yet devised.



5. The rectifiers, mounted on copper plates for heat radiation, operate over a wide temperature range with no special cooling.

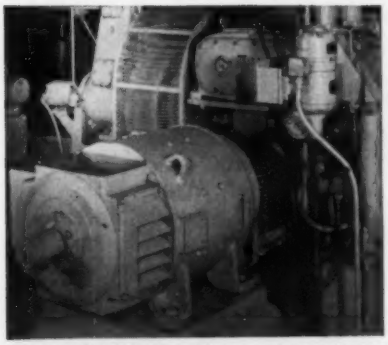


6. Complete panel can be checked quickly for start-up and trouble shooting with the optional test fixture . . . one meter, one knob.

7. Motor control is precise . . . 1/10% regulation at base speed, with response times up to twice as fast as tube type regulators.

8. The Reliance V★S Drive control cabinet is 35% smaller than conventional drives. Cabinet can be located where convenient.

9. Operator's station centralizes drive operation. Multiple stations, bench boards, pendent stations and special controls available.



10. The Super-T D-c. Motor . . . integral part of the V★S Drive. It's rugged . . . absorbs repeated 100% overloads for one full minute.

Your nearest Reliance Systems Engineer will give you all the facts . . . help you apply Reliance V★S Drives to your products and processes. Call him through the Yellow Pages, or write us direct.

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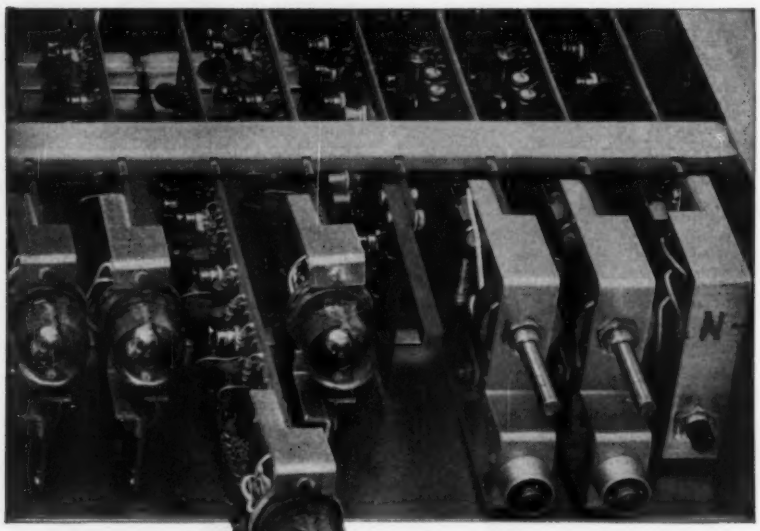

THIS IS WHERE IT COUNTS

NEW ERIE SOLID STATE 500T BI-DIRECTIONAL CONTROL COUNTER

This is a rugged high-speed control counter with bi-directional capabilities for digital closed loop control. It offers for the first time anti-coincidence circuits for random add/subtract inputs, a digital-to-analog converter and an excess error alarm. The instrument has true modular construction in which individual circuit boards are readily inserted from the front for functional versatility and ease of maintenance. In-line NIXIE readout can be supplied when required.

The unique anti-coincidence circuit used prevents interference between add and subtract pulses arriving simultaneously. This provides absolute accuracy as opposed to conventional anti-coincidence circuits. The analog output is proportional in both magnitude and polarity to the algebraic sum of the add and subtract inputs. The readout indicates the instantaneous algebraic sum.

For example, where the 500T is used for control of motor speeds, the pulses arrive at both the add and subtract inputs at exactly the same rate when the controlled motor is running at the desired speed. Any speed change develops an analog output to a servo system which returns the motor to the proper speed. The same basic process would apply to the mixing of liquids or chemicals.

Applications for the 500T are virtually unlimited since it provides digital control of such parameters as flow, speed, position, and many others. An industrial case is available for applications in rugged environments.

Rack Mounting Model

Industrial Model

Complete technical information available on request.

Quality Where It Counts

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automatic means if further testing indicates that additional economic gains would result.

Galt, Ontario

In an effort to regain markets lost to foreign competition, Lawson Co. Div., Miehle-Goss-Dexter Inc. has redesigned its line of paper cutting machinery and awarded a manufacturing contract to the Canadian firm of R. MacDougall Co. Div., Upton Bradeen & James Ltd. Only components made in the U. S. and Canada will be used in fabrication. The move is expected to create increased employment and business in both countries.

Buenos Aires, Argentina

An order for a $180,000 rotary pipe mill has been placed by the major steelmaking firm of Acindar S.A. with Mackintosh-Hemphill Div., E. W. Bliss Co. The unit, complete with entry and delivery tables, can straighten pipe in sizes from $\frac{3}{8}$ to 4 inches at speeds up to 900 fpm.

Interlaken, Switzerland

International standards for electrical characteristics of digital computers and data processing machines are subjects of study by a committee recently set up by the International Electrotechnical Commission. Dr. A. B. Credle, International Business Machines Corp., is chairman of the new IEC Technical Committee 53 which will develop standards relating to graphical symbols; input-output media involving magnetic tape; and levels of current, voltage, and impedance for data transmission.

Aylesbury, England

Photoelectric scanning and digital data transmission equipment developed by General Precision Systems Ltd. can identify moving objects which are fitted with inexpensive reflector code plates. Designated Teletrac, the system can be used to monitor and control the movements of trucks, buses, and freight cars. It can also be applied to discrete materials and workpieces in factories. In operation, the code plates are scanned at predetermined check points and signals are fed to central control equipment for classification and visual display or recording.

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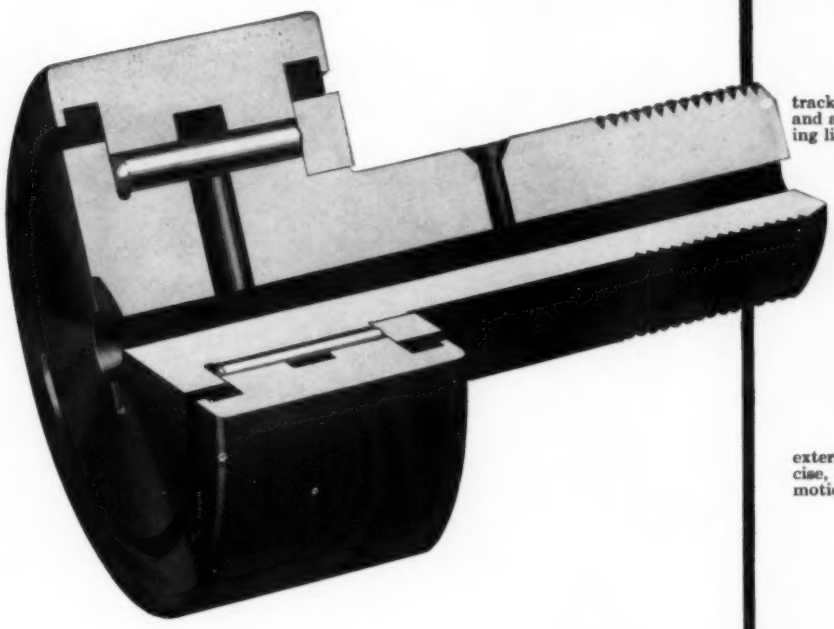

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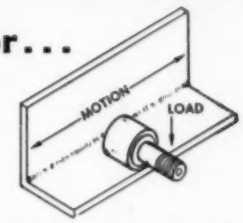

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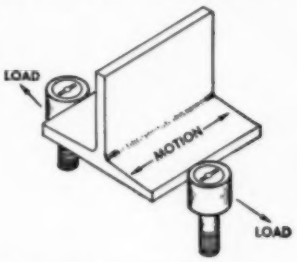

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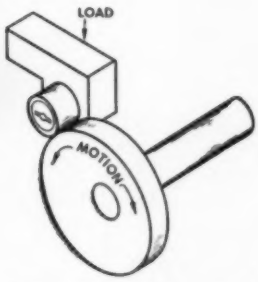

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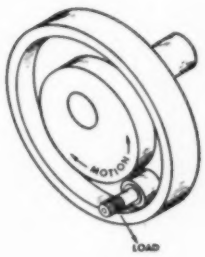

internal cam applications

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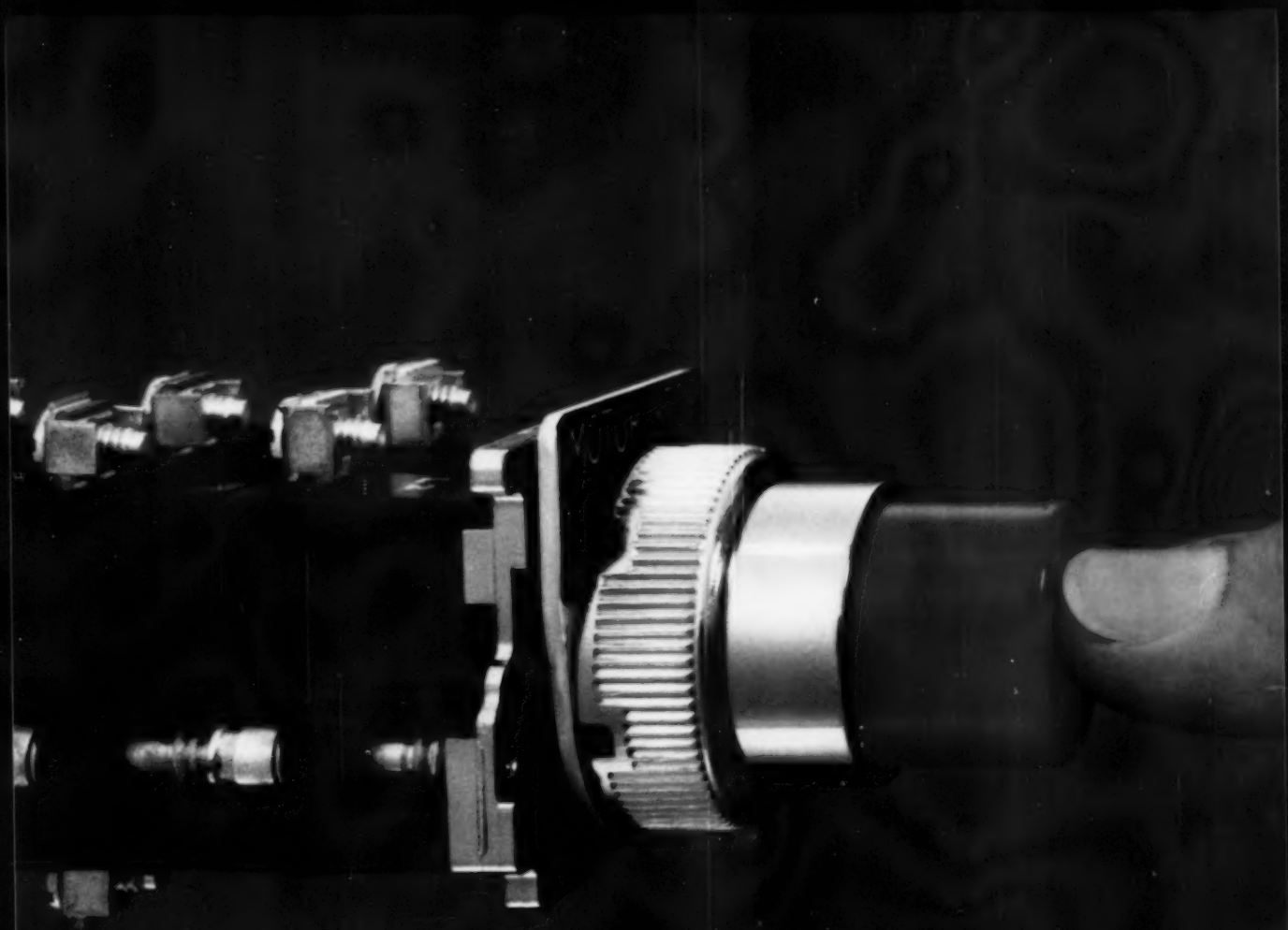

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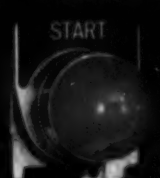

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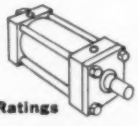

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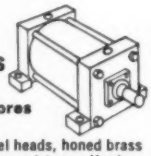

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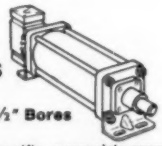

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Look at Systems

When reduced to concept, the practice of systems engineering can be described as a method of approaching engineering problems by building a larger perimeter around the area of study. The systems engineer is trained to ask questions about matters that were classically considered outside of the scope of the problem at hand.

Within the framework of the dictionary's definition of a system: *An assemblage of objects united by some form of interaction or interdependence,* a nut on a screw is a fastening system. This in turn may be part of a higher order of complexity and hold a cover to a gear case. The cover retains oil and is part of a lubrication system. The case supports gears thereby being part of a power transmission system, which in turn is part of a speed control system, that is part of a production machine (system), that is part of a manufacturing system, that is part of a corporate system, within an industrial system, in a social system, in a governmental system, in a world system, in the solar system. When it comes to encompassing wider areas than the original statement of an engineering problem, the sky isn't even the limit.

Enlightened manufacturing management has seen the merits in applying the systems engineering concept to production problems. In considering a system at any level, its component subsystems must be properly related to each other, and it in turn must be a well integrated subsystem of the next order system.

One complication that arises in implementing this concept into practical industrial transactions, is that of specifying the extent one system designer is expected to analyze the next higher order system in performing the engineering required for his part of a development. Those who expect to get a complete control system design for the price of the components are as off-base as those who may wish for a complete design of a manufacturing system for the price of a special packaging machine.

The purchaser should expect his sources to be competent in taking a systems engineering approach to manufacturing problems, and should in turn set specifications for the engineering he requires, and be willing to pay for services rendered. Advancements in automation depend to a large degree upon industrialists understanding these concepts.

James C. Keebler

EDITOR

AUTOMATION

Semiautomatic and automatic equipment is available for packaging operations in manufacturing plants. The author discusses some of the considerations involved in use of such equipment—as integral elements of complete processing systems and as isolated units fed by hand.

By **CHARLES T. RAYMOND**
Vice President
Automation Engineering Laboratory Inc.
Stamford, Conn.

PACKAGING IN MANUFACTURING

HIGH DEGREES of packaging automation have existed for many years in some industries but they have been feasible mostly in packaging operations where production runs are long and machinery flexibility requirements are reasonably confined. For example, items such as canned foods, razor blades, breakfast cereal, bottled beverages, household chemicals, and many pharmaceutical products are made and will continue to be made in tremendous quantities. Although many of these products are merchandised aggressively through dynamic package design, the size and shape of their basic packages are not subject to frequent changes. Without too much imagination management can determine the economies of high speed production, and it is not surprising that the packaging operations in these industries, and many others like them, are automated to a high degree.

At the other extreme, however, are many companies which have very slow packaging lines. Some hardware companies, for example, have packaging operations which are almost entirely manual. These firms may be large and have enormous total production, but they manufacture so many different items, each in several sizes, that they cannot schedule production runs long enough to permit the use of high-speed automatic packaging equipment.

The biscuit industry, on the other hand, has predominantly long runs of fairly similar items. Although most other phases of biscuit production are highly automated, the packaging area normally includes at least one manual operation. There are two explanations for this seemingly inconsistent situation. In the baking industry, even though the product itself is stable year after year, packaging is a merchandising tool. It is subject to frequent changes, and this limits the opportunities for savings through automation.

Probably even more important than this, however, is the fact that machinery for handling the product of biscuit lines was not available until recently. The operations such machinery has to perform are so

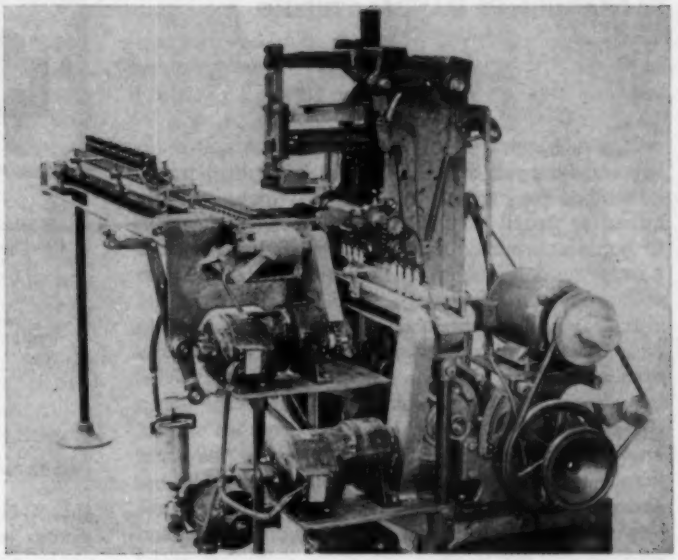


Fig. 1—Labeling machine uses multiple handling approach to obtain higher output while still using reciprocating motions. Four bottles are labeled simultaneously in the setup shown.

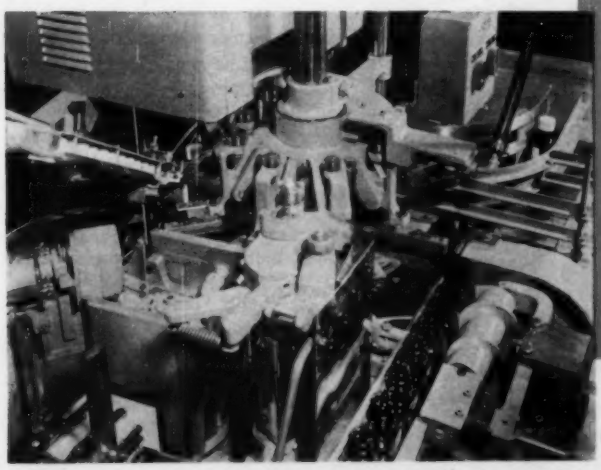
Courtesy, New Jersey Machine Corp.

complex, because of the diversity of sizes and shapes of biscuits and their broad dimensional tolerances, that no one had yet invented devices capable of performing them. This differs from the hardware industry in which the required equipment often is available but cannot be justified because of short runs and extreme flexibility requirements.

▶ Initial Considerations

In analyzing packaging operations for possible automation, prime consideration should be given to the anticipated cost reduction effected by the contemplated automated method relative to its cost. Other important factors include expected length of runs, probability of product changes, and probability of package change. Investments in automation in the packaging field which will pay for themselves in two to three years through reduced cost are ordinarily considered attractive.

The payout period of two to three years is less than the three to four years ordinarily deemed appropriate for processing equipment. Packaging machinery is subject to more obsolescence because of merchandising and packaging trends than is the equipment which processes the product itself. In many cases there are also factors of quality of product, safety, floor space utilization, and time to be analyzed when considering automated packaging methods.



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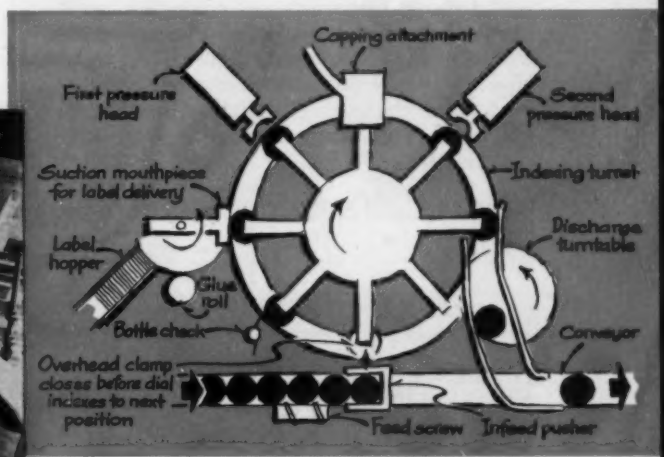


Fig. 2—Labeler with a capping attachment is an example of a relatively slow-speed machine in which a pusher loads one bottle at a time into an indexing turret. Label delivery is not performed at third station if no bottle was sensed at second station.

It may be established that the product and package will be stable and the savings through upgraded automated packaging will justify the investment required to install it. Then the question can arise as to how the proposed new packaging function should be organized and how it should be related to other activities in the company.

Packaging is a production process and should be treated accordingly. When a company's product is considered to be the entire item which is shipped—including the basic product and its package—then the packaging operation can be approached as just another assembly operation. It contains the same management problems as any other assembly operation—the management of materials and personnel, the balancing of costs, scheduling, maintenance, and so forth. This is especially true of higher speed packaging operations since it is often feasible for them to be integrated closely with other production operations.

Since packaging machinery is likely to be operated and maintained alongside production machinery, it should meet the codes and standards set for production machinery. The responsibility for seeing that it does, and that it is satisfactory production equipment in general, should reside with the manufacturing engineers.

To be sure, in some industries packaging operations are very different from the operations which are used to manufacture the company's product. In such cases, it may be appropriate that packaging be organized differently, located separately, and often treated in a unique fashion. Some parts of the cosmetics industry can be cited as illustrations of appropriate segregation of packaging. The preparation of cosmetic items is sometimes merely a matter of mixing liquids. The packaging operation, with its very different machinery and production techniques, has so little in common with the manufacturing operation that it is appropriate that it be segregated. However, in plants having integrated channels of production, the packaging function should be considered as part of manufacturing engineering responsibilities.

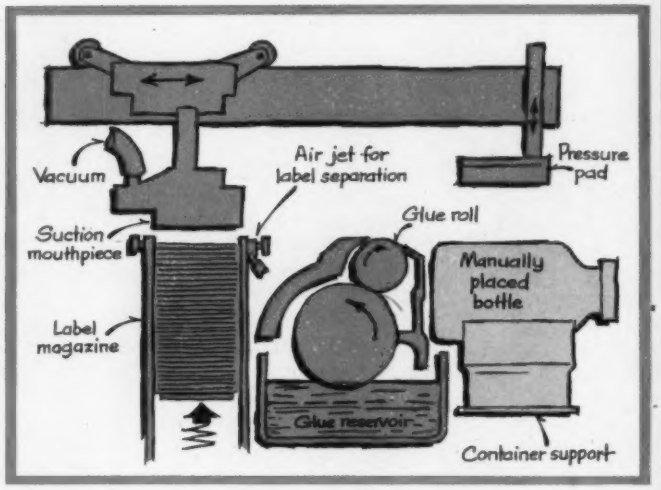


Fig. 3—Elevation sketch of a labeling arrangement indicates reciprocating motion which can pick up and apply labels to bottles at a maximum speed of 30 to 60 per minute. In this design used by New Jersey Machine Corp. a suction head picks up a label, carries it over a glue roll, and deposits it on the container. A pressure pad then descends to press the label into intimate contact with container.

High Speed Factors

As machine speeds have increased, the problems of feeding packaging materials and products have increased also. In order to achieve higher speeds for packaging machinery, manufacturers of this equipment have turned to two general engineering principles: Use of continuous motions to avoid the limited speed of intermittent motions, and use of multiple handling devices so that more than one package can be handled for each stroke of the machine. Continuous motion has been applied to all types of bottling equipment including bottle cleaners, fillers, cappers, and labelers. Multiple handling has been applied to labelers, such as the one shown in *Fig.* 1, to enable the machine to label several hundred bottles per minute by making only 40 to 60 strokes per minute.

For items such as bottles, slower speed machines can use a simple device such as a right angle pusher

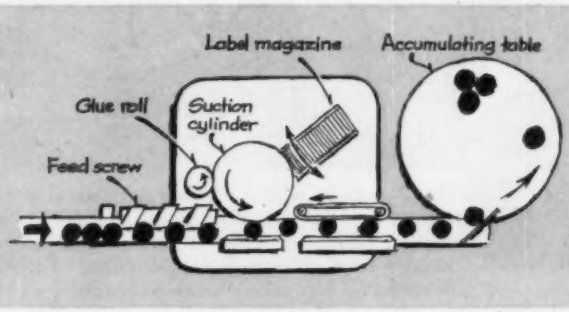


Fig. 4—Plan view illustrates high-speed labeler in which bottles move through the machine in a straight line with continuous motion. An oscillating magazine feeds labels to a continuously rotating suction cylinder which carries them past a glue roll and applies them to bottles spaced by the feed screw. New Jersey Machine Corp. uses this arrangement to apply labels to 300 bottles per minute.

to feed one bottle at a time from an infeed conveyor into a work station where it will be filled, capped, or labeled, perhaps in conjunction with an intermittent indexing motion as in the machine shown in *Fig.* 2. Or, a reciprocating motion may be used to pick up and apply labels to bottles at maximum speed of 30 to 60 per minute as in the semiautomatic method illustrated by *Fig.* 3.

As speeds are increased an abrupt reciprocating motion is much too harsh in its handling of a product and builds up greater and greater stresses within the machine due to the disproportionate increase in the acceleration of the machine's parts. In order to feed bottles at higher speeds, star wheels can be used in place of the reciprocating pusher. Star wheels serve the same purpose as reciprocating pushers of separating bottles and delivering them in timed relationship to the working head of the machine.

At even higher speeds, feed screws can be used to time and transfer bottles. Feed screws operate in continuous motion and are practical even at quite high speeds. They can be made longer for high speed operations where the handling of the bottle must still be fairly smooth and gentle.

One example of the use of a feed screw is the high speed rotary labeling machine indicated by *Fig.* 4. This machine also uses a multistation rotating drum which travels in continuous motion and applies labels to 300 or 400 bottles per minute. Additional examples of high speeds achieved through the use of continuous motion or multiple handling include rotary fillers, *Fig.* 5, continuous motion cartoners, *Fig.* 6, and multiple weighers, *Fig.* 7.

A broad variety of packaging machines including labelers, cappers, cartoners, and many box-forming machines use suction to feed material one piece at a time from stacks in hoppers. Some box blanks and folding cartons are fed by means of a reciprocating blade cutoff arrangement at the bottom of a hopper, *Fig.* 8. Such a design is often varied by making the blade part of a continuous motion device. This increases the attainable speeds.

For ultra-high-speed feeding of difficult packaging materials, such as labels or package wraps, the problem of sheet separation and feeding can be effectively solved by turning to machines which use labels, or wrappers which have been printed on a continuous web of material. Such "roll feed" devices utilize photoelectric cells or mechanical detectors to register the strip of printed material so that it can be cut appropriately into individual sheets. Almost all wrapping machines are now arranged to feed materials from a roll, and, as speed demands increase, many labeling machines are being supplied with roll feeds *Fig.* 9.

▶ Integrated Operations

There is a great variety of fully automatic machines for performing packaging operations such as wrapping, cartoning, boxing, bagging, and so forth. Many packaging machines have also been arranged to perform adjunct operations such as inspection, marking, assembly, counting, folding, and inserting leaflets while also performing their basic function. Labeling machines are available equipped with attachments for marking the labels with price, expiration date, color, identification number, or other data prior to affixing the label to the package. Attachments are available for cartoners to imprint cartons in a similar fashion *Fig.* 8.

In the paper industry there is a machine available for combining the packaging operation with a cutting and collating sequence for the production of cards. When handling packages which contain more than one item, packaging machinery can often be equipped to simultaneously feed the several items to be contained in the one package, thereby combining the packaging operation with an assembly or collating operation.

However, there are comparatively few installations in which packaging machines can be used in a highly automated line fashion—that is, integrated with the upstream operations so that the product to be packaged is transferred automatically into the packaging line from previous machines. These transfer operations have remained manual because ordinarily they involve the difficult task of feeding hard-to-manage items such as candies, cookies, meats, or odd shaped parts from bulk supply. They may

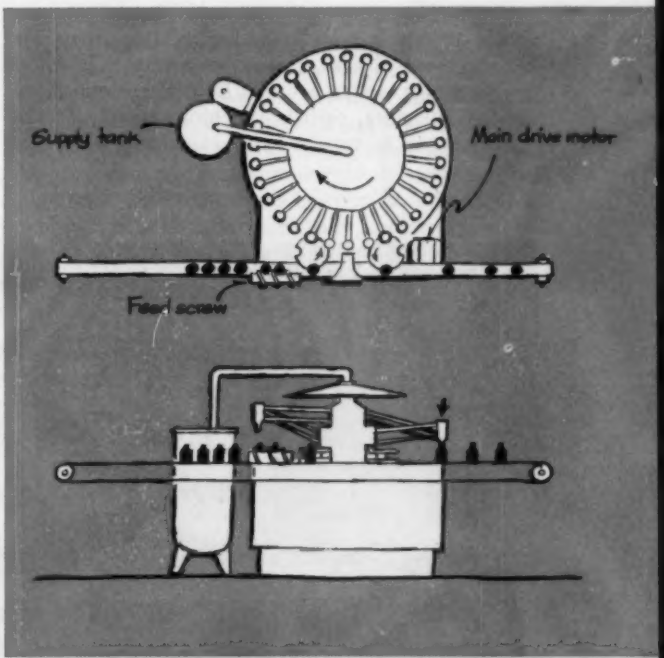
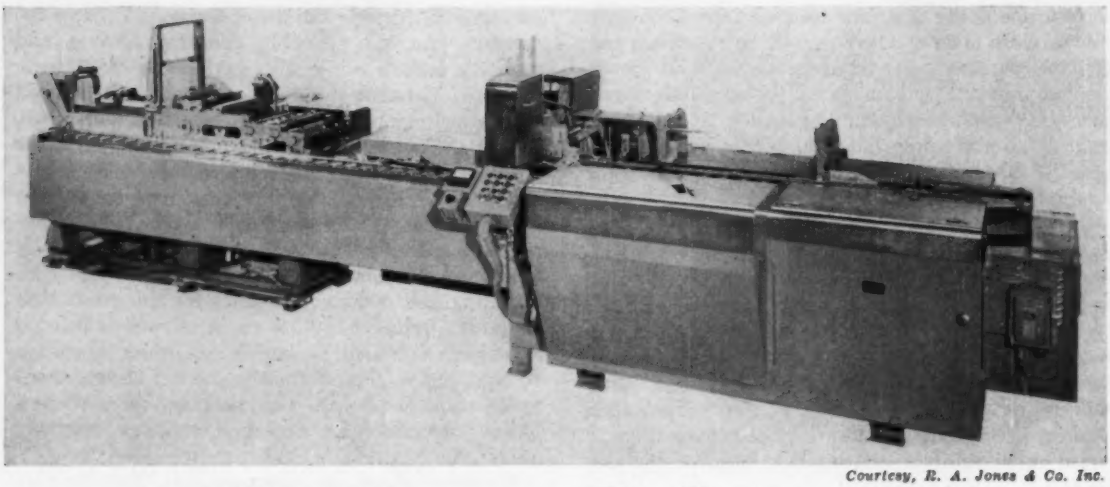


Fig. 5—Sketches illustrate 30-head bottle filling machine which also uses continuous motions to obtain high speeds. Pneumatic Scale Corp. Ltd. supplies machines using this arrangement to receive empty bottles on a conveyor, fill them while the turret carries them around under a filling head, and discharge the filled bottles on a conveyor.



Courtesy, R. A. Jones & Co. Inc.

Fig. 6—Continuous motion cartoner sets up 200 to 400 cartons per minute. Unit shown also includes an attachment that folds and inserts leaflets in the cartons.

also involve the task of transferring materials from the previous machine to the packaging machine and simultaneously performing an inspection operation on them. This presents an immediate complication since the inspection operation must be capable of setting aside rejects. Such action alters the flow rate of the product so that an automatic adjustment must be made in the speed of the packaging machine to compensate for the rejects.

If several packaging machines are to be used together in an automatic packaging line, they can be integrated in one of four basic ways: 1. All of the machines can be powered from a common drive, thereby effecting perfect synchronization. 2. The machines can be synchronized electrically by means of synchronous motors. 3. Accurate speed controls can be used. 4. The machines can be arranged so that each will operate independent of the rest but will be controlled by a sensing device which detects the oncoming flow of product and controls the machine accordingly.

It is common practice in high speed packaging lines to have each machine operate at a speed slightly higher than the machine before it. Each machine is then equipped with a sensing device which controls a latching device that causes the machine to miss strokes if the supply of product waiting to pass through it is not at least a predetermined minimum amount. This method of integration is probably the most common in the packaging industry, and it is

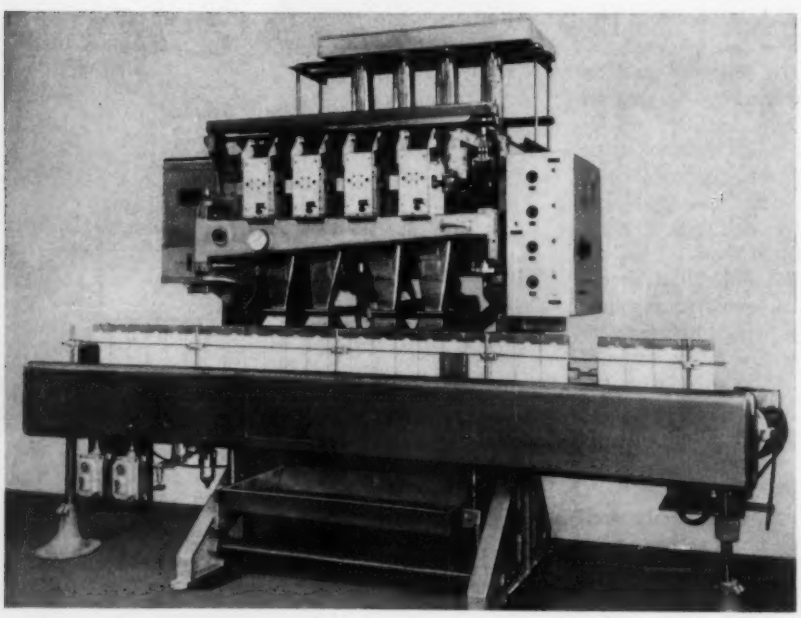


Fig. 7 — Four-scale weighing machine loads cereal packages four-at-a-time. Although intermittent action is used, the multiple handling technique permits a high rate of output.

Courtesy, Pneumatic Scale Corp. Ltd.

Courtesy, Bivans Corp.

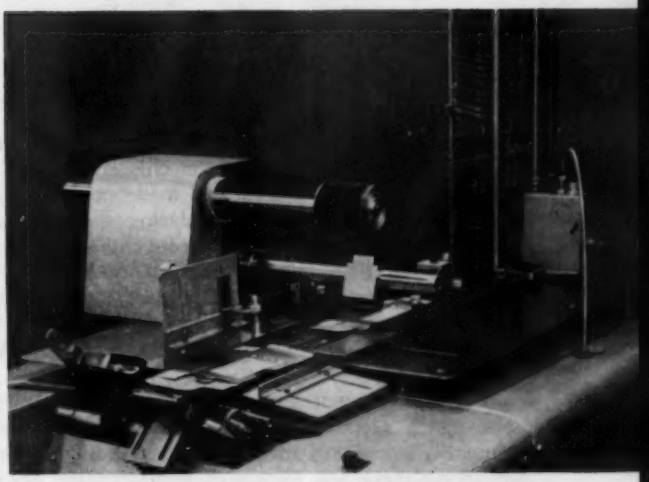
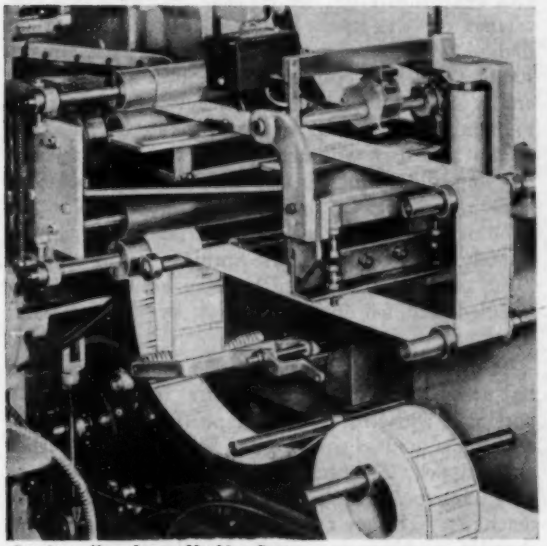


Fig. 8—In this semiautomatic cartoner the carton blanks are fed from the bottom of the supply stack at right. A reciprocating blade withdraws one blank at a time. The blanks are then imprinted, set up, and carton flaps tucked into place.

standard practice among packaging machinery manufacturers to equip their machines with automatic latching devices for this purpose. Ordinarily, with no modification, a machine so equipped can be used in conjunction with almost any other standard packaging machine. Utilizing electrical synchronization or a common drive would involve extra expense because of the special parts which have to engineered and built for each combination of machines to be integrated.

This complicated area of integrating high-speed packaging machinery with upstream production or processing units is one of the most challenging areas for automation in the packaging field.



Courtesy, New Jersey Machine Corp.

Fig. 9—Roll feed labeler indicates means used to obtain higher speed labeling action. Unit shown includes an imprinting attachment to print special information on each label.

▶ Semiautomatic Packaging

Semiautomatic machinery is given this designation since it usually performs part of its packaging operation mechanically, leaving the balance to be done manually. In the case of cartoners, the semiautomatic will feed cartons from a stack, set them up, and close them. It will leave the operation of loading the product into the box to be accomplished manually. Semiautomatic labelers glue a label to a bottle, box, or other item fully automatically, but the item to be labeled must be placed into the machine manually. Because they do only part of the operation, the semiautomatic machines generally

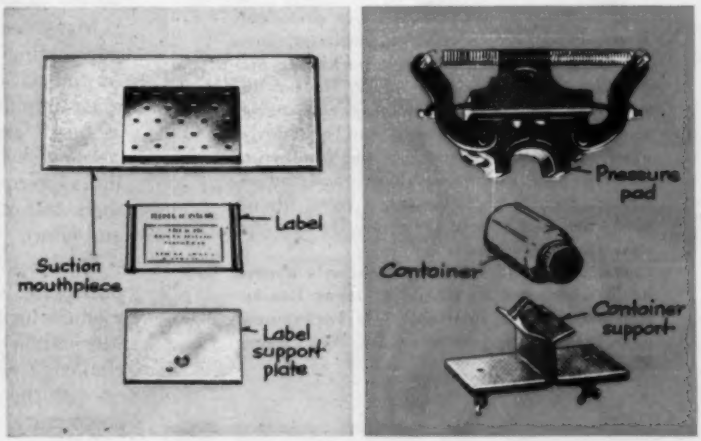


Fig. 10—To improve adaptability of packaging machines for a variety of products, the machines may incorporate quick change features such as these change parts. New Jersey Machine Corp. uses sets of such parts to provide rapid changeover on the semiautomatic labeling machine illustrated by *Fig.* 3.

have fewer parts and are usually much smaller than are fully automatic packaging machines.

Semiautomatics are very often made portable by mounting them on casters or placing them on a skid which can be moved with a conventional warehouse truck. This provides even more versatility for the machinery since it can be used in different locations throughout the plant or in different combinations for the next product to come through the packaging line.

As we have mentioned, there are many conditions which dictate that semiautomatic, not fully automatic, packaging methods be used. For these operations there are numerous semiautomatic machines available for every packaging job. In addition to being less expensive, semiautomatic packaging machines ordinarily have the advantages of a wide range of adjustability and more flexibility in the variety of packages they can handle.

For semiautomatic labeling, extremely versatile machinery is available. Typical of many semiautomatics, such a labeling machine has been designed for quick changeover by utilizing a system of change parts, *Fig.* 10. One set of parts can be easily removed from the machine and replaced by a second set of parts which are custom made for the next job to be run. This same system of change parts is common in wrapping machines, cartoning machines, and box forming machines.

Parts which must be interchanged are often held in place by thumb screws or a pilot pin equipped with a ball detent so that the part can be snapped on and off quickly. In addition to change parts, quick changeover can be accomplished by designing machinery so that certain often used adjustments, guide rail spacing for example, can be adjusted by turning a shaft equipped with right and lefthand threads so that adjustments on both guide rails can be accomplished in one quick operation.

Because of this quick changeover and accompanying broad range of adjustability, semiautomatic machines are often used even though fully automatics could be justified. Fully automatics are sometimes not available for the particular size package to be handled, whereas semiautomtics often are.

Industrial Packaging Trends

The trend in industrial packaging is toward more and more utility for the package and increased cost savings for the user. Whether it is performed on highly automated lines or not, proper packaging of supplies can be a cost saver for almost any company and a sales inducement for its customers. Difficult to handle items, such as springs, can be packaged so that the user will not have to spend money untangling the springs before they can be used. By adhering springs to pressure sensitive tape or by winding them on a reel of material having appropriately spaced pockets, the springs can be shipped in an oriented fashion so they can be automatically handled and fed into machinery by the industrial consumer.

Transistors and electronic components can also be used at considerable savings if appropriately packaged with this type of tape reel. The biscuits which are used as covering for ice cream sandwiches are shipped in special containers, prestacked, so they can be placed conveniently in sandwiching machines. The ice cream manufacturer using them thereby avoids unnecessary handling.

Increasing use is being made of reusable containers for industrial packaging. It is common for glass bottle manufacturers to ship bottles to customers in corrugated containers which will then be emptied onto bottling lines. After the bottles have been filled, the container will be reused by the bottler to ship them to market.

Many stacked items, such as box blanks, labels, and folding cartons, are similarly packaged in counted and stacked groups for convenient handling. Tiny glass ampules used in the drug industry are manufactured and shipped in groups which are surrounded by a tape strap which enables the user to lift a precounted supply of the ampules and insert them into packaging machinery with minimum time and effort.

It is apparent that these many refinements in packaging will make new and greater demands on manufacturing engineers to increase packaging abilities while decreasing packaging costs. It is this challenge which has made automation in packaging one of the most dynamic areas in our industrial community.

THE AUTHOR

CHARLES T. RAYMOND, vice president, Automation Engineering Laboratory Inc., has been connected with the packaging machinery field for eleven years. He has invented many types of packaging, converting, and processing machinery and has developed automated systems for the production of items such as extensive edge candy boxes, games, record packets, paper cups, biscuit packages, and textile products. He has also sold such equipment.

Mr. Raymond holds a bachelor's degree in Management Engineering from Rensselaer Polytechnic Institute. His background also includes experience with New Jersey Machine Corp.

OVERHEAD CONVEYOR FEEDS PARTS TO MOTOR ASSEMBLY

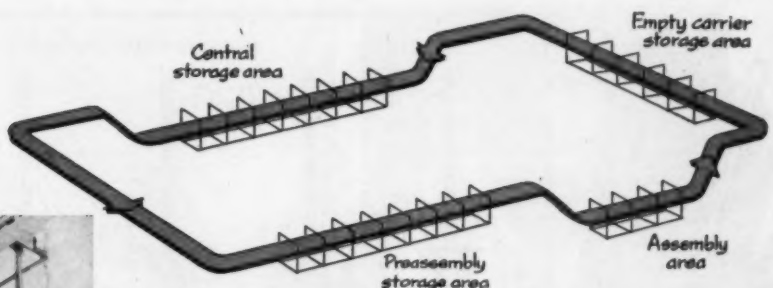
FREE and power overhead conveyor system has been installed at Wagner Electric Corp. to transport fractional-horsepower motor parts from a centrally located parts storage area to an assembly area. This system differs from conventional systems in that free track is used only at four sections where carrier loads are to be temporarily halted, and no free track is used between these sections.

In the central storage area specially designed carriers are each loaded with parts for the assembly of 20 motors. At this point the carriers are suspended from a low-level section of free track which is at a height convenient for manual loading at floor level. Loaded carriers are then positioned in readiness for pick-up by a fixture suspended from the power conveyor. The power conveyor fixture contacts the carrier and lifts it from the free track for movement to overhead storage on a second section of free track. At this point the fixture disengages from the carrier, and the carrier is free to roll on the free track.

When an operator is ready for parts in the assembly area, the power conveyor picks up a loaded carrier from the overhead storage area and delivers it to a low-level free track where the operator at floor level can select parts from the carrier. As soon as the carrier is emptied of parts, it is again picked up by the power conveyor and delivered to a fourth section of free track where the empty carriers are stored just below ceiling level. The cycle is repeated when the central storage area operator is ready to reload a carrier and causes the power conveyor to deliver an empty carrier to his area.

The system saves considerable manufacturing floor space since the carriers are moved and stored at ceiling levels. A saving in equipment cost is also effected since the free track is used only at the points where the carriers will be in an idle position. In practice, 15 parts carriers carry sufficient parts for the assembly of 300 motors.

Control and actuation of the system is by limit switches, solenoids, and air cylinders. Manual positioning of the carriers for pick-up is required in both the storage and the assembly areas. Otherwise, the operation of the system is automatic. The system was designed by the Material Handling Dept. of Wagner Electric in co-operation with the General Automatic Transfer Co. who provided the equipment.



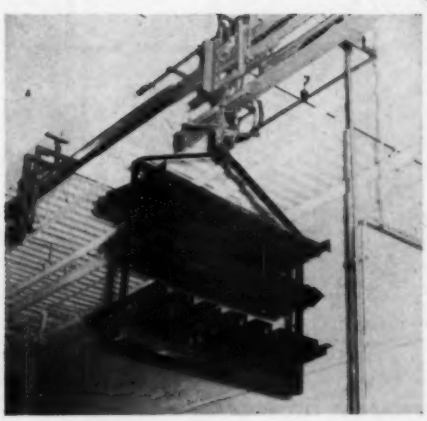


Diagram illustrates the layout of a free and power overhead conveyor system which uses free track only at sections where conveyor carriers will be temporarily halted. A typical carrier is shown in the photograph. The carrier is stopped on a section of free track in the preassembly storage area. Leading off to the left is the power conveyor of the system.

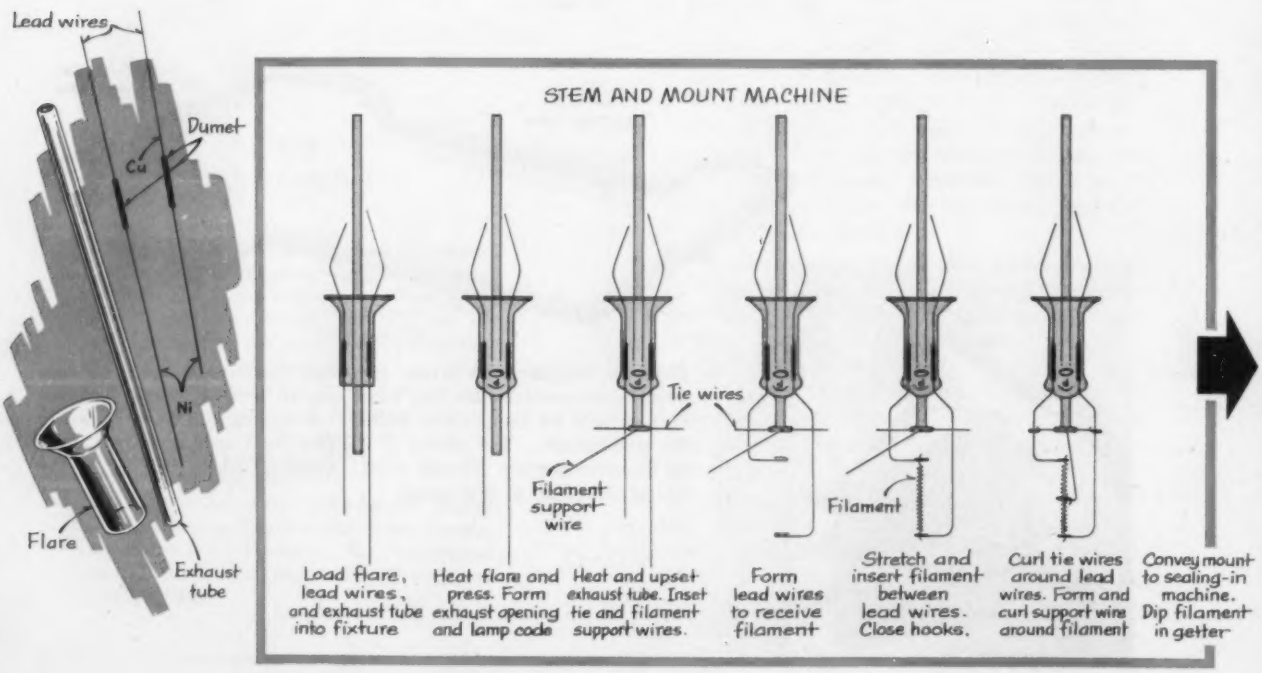
AUTOMATION TODAY

MAKING INCANDESCENT LAMPS

By **JULIAN E. WILBURN**, Associate Editor

MECHANIZATION of production processes for manufacturing incandescent lamps is not a recent development but a continuation of efforts that began in 1914 with the development of a sealing-in machine, which automatically indexed lamps to successive working positions. Since that time many advances have been made in the productivity of labor and machinery for the manufacture of lamps and lamp parts. Detailed technical information about these advances has been closely guarded by individual lamp-making companies and has not been generally available to other industries that could use many of the production techniques in the manufacture of nonrelated products. This reticence on the part of lamp manufacturers has been primarily due to the competitiveness of the lamp business. In fact, many manufacturers design and build their own machines so that details of production importance cannot leak to a competitor through outside designers or builders.

However, at the rate that technology in all fields is advancing today, closely guarding production processes no longer offers the advantages of yesterday. A process, machine, or device that provides a competitive advantage today may become technically obsolete tomorrow. With these thoughts in mind, the Lamp Division of Westinghouse Electric Corp. has co-operated in providing certain proprietary information and illustrations of one of its newest and most highly automated production systems for assembling incandescent lamps. This 70-foot-long production system was developed by Westinghouse en-


Lead wires
Dumet
Cu
Ni
Flare
Exhaust tube
STEM AND MOUNT MACHINE
Tie wires
Filament support wire
Filament
Load flare, lead wires, and exhaust tube into fixture
Heat flare and press. Form exhaust opening and lamp code
Heat and upset exhaust tube. Inset tie and filament support wires.
Form lead wires to receive filament
Stretch and insert filament between lead wires. Close hooks.
Curl tie wires around lead wires. Form and curl support wire around filament
Convey mount to sealing-in machine. Dip filament in getter

Load clear glass bulbs into vibratory feeder bowl. Feed bulbs to coating machine.

COATING MACHINE

Coat inside of bulb with fine silica powder and set coating. Transfer bulbs to vertical elevator and then to horizontal conveyor.

MONOGRAMING UNIT

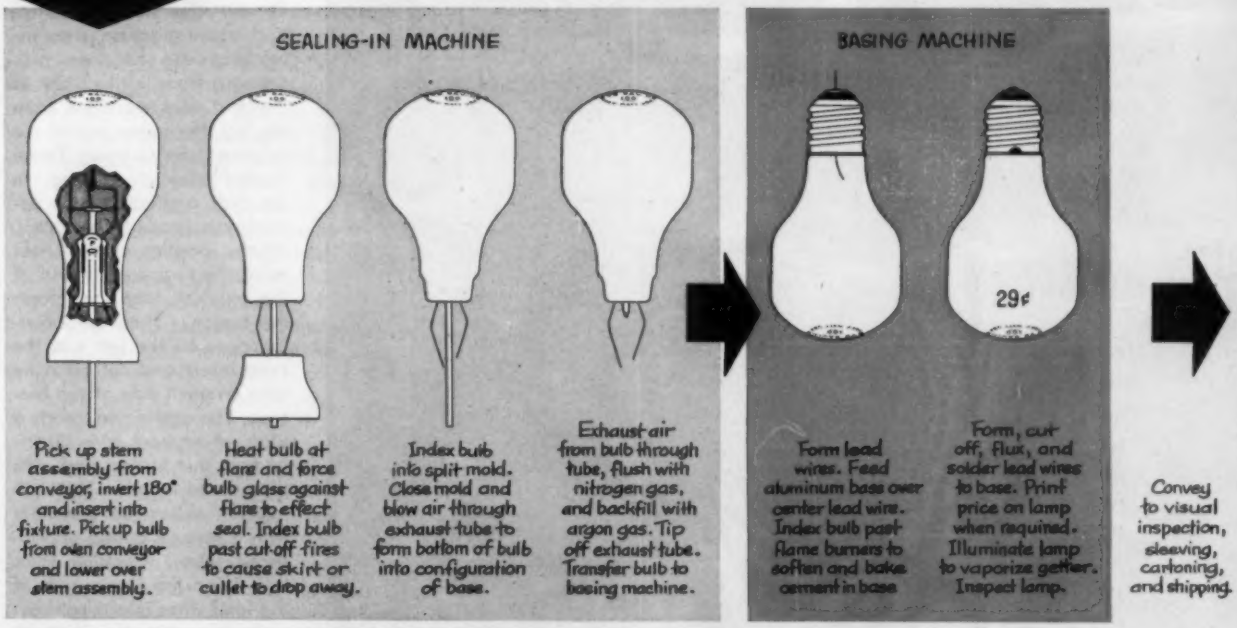
Coat top of bulb with name, wattage, voltage, trademark and USA. Then convey bulb to sealing-in machine and move bulb through oven to remove water of crystallization from silica coating.

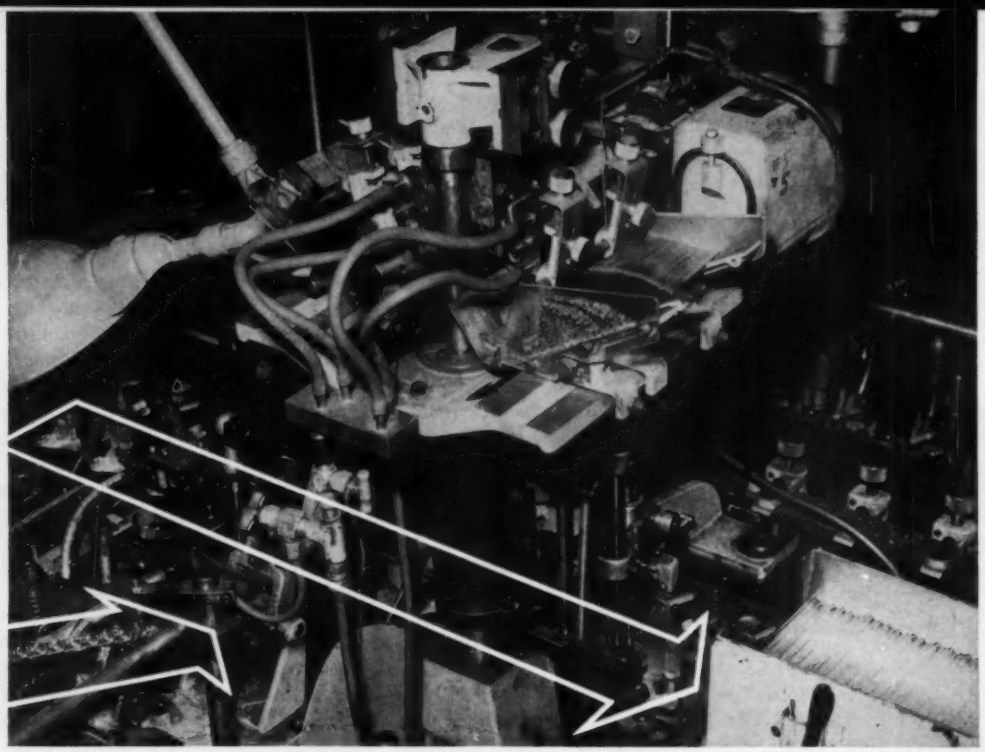
gineers and is capable of producing up to 3000 lamps per hour. The guiding philosophy in the design of the system was to process the maximum number of pieces, with the minimum attention by personnel, with the simplest design compatible with automatic handling, and with minimum waste of parts.

Many of the processes illustrated are not new in the sense that they were developed for this particular system. For example, stem and mount machines, sealing-in machines, and basing machines have been used as individual pieces of automatic equipment for many years. However, the process of electrostatically applying a coating of fine silica particles to the inside surface of a bulb is a new technological advancement that avoids an acid etching process formerly used. The development of this process and the development of techniques and devices for interconnecting various individual automatic machines has permitted the integration of all phases of lamp assembly into a unitized system.

The lamp production system consists of four major assembly machines, monograming unit, and two packaging machines which are integrated into a unitized complex by conveyors, parts feeders, and loading and unloading devices. The four assembly machines are the stem and mount machine, the sealing-in machine, the basing machine, and the silica coating machine. Following automatic testing, completed lamps are automatically loaded into paper sleeves on a sleeving machine, and the sleeves are

1 Flow diagram illustrates the major processing steps in the assembly of incandescent lamps on an integrated multimachine complex. The various parts of the lamps—flares, exhaust tubes, lead wires, filaments, clear glass bulbs, and aluminum bases—are prepared off the line and are fed into the assembly at the proper time. Rated output of the complex is 3000 lamps per hour.


SEALING-IN MACHINE
BASING MACHINE
29¢
Pick up stem assembly from conveyor, invert 180° and insert into fixture. Pick up bulb from oven conveyor and lower over stem assembly.
Heat bulb at flare and force bulb glass against flare to effect seal. Index bulb past cut-off fires to cause skirt or cullet to drop away.
Index bulb into split mold. Close mold and blow air through exhaust tube to form bottom of bulb into configuration of base.
Exhaust air from bulb through tube, flush with nitrogen gas, and backfill with argon gas. Tip off exhaust tube. Transfer bulb to basing machine.
Form lead wires. Feed aluminum base over center lead wire. Index bulb past flame burners to soften and bake cement in base
Form, cut off, flux, and solder lead wires to base. Print price on lamp when required. Illuminate lamp to vaporize getter. Inspect lamp.
Convey to visual inspection, sleeving, cartoning, and shipping.



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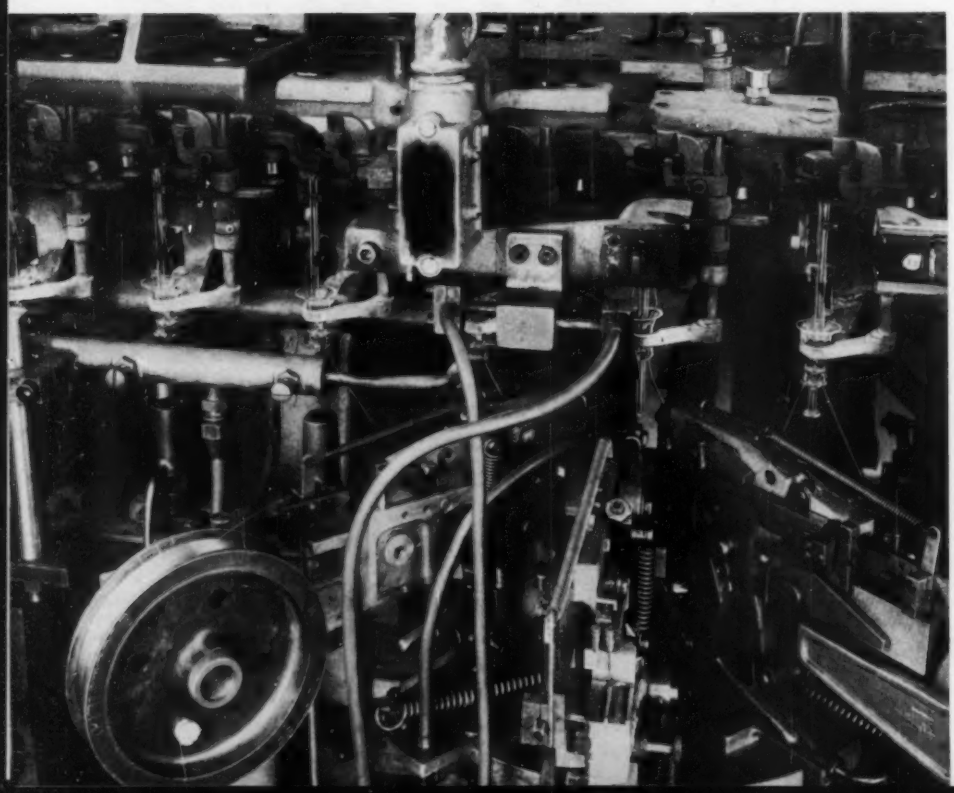
Tractor-type indexing machine shown makes stem and mount assemblies. Location and line of travel of part fixtures is outlined by large arrow. Glass flares are first fed into the fixtures from a sloping track (lower left) which is supplied by a vibratory bowl feeder. The two different types of lead wires are fed from the feeders in the center of the picture. The wires are stacked on each side of the column and are picked up in vacuum fingers and dropped into funnels which lead into the flares. At the lower right is the feeder for the glass exhaust tubes. All of the part feeding operations are controlled by feeler devices so that the next part will not feed if the previous part was not fed properly. After the parts are loaded into the fixtures, the units are indexed through a series of fires and pressing formers that soften and shape the stem and blow a hole connecting the exhaust tube to what will become the inner part of the lamp.



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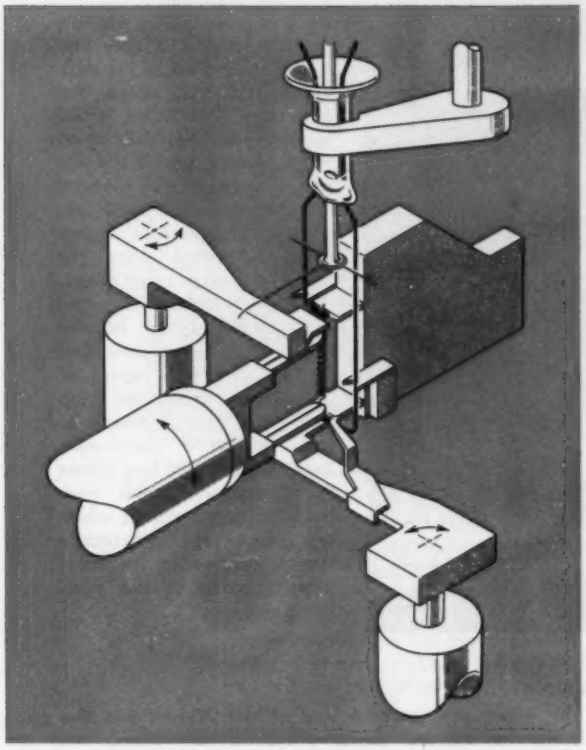
On the other side of the stem and mount machine, stem assemblies can be seen progressing from left to right. In the first four positions from the left, the lower end of the exhaust tube is being flame heated prior to upsetting. In the fifth position a stem assembly is ready to be upset. At this position a tool rises vertically to upset the end of the exhaust tube and form the button. Then the inserting guns on the left and the right insert and cut off a tie wire on each side of the button. The center gun inserts a filament support wire directly into the button and cuts the wire to length. The sixth position shows an assembly with a formed button and inserted wires. Forming tools then bend the lower ends of the lead wires into a configuration to receive the filament.



4 Coiled-coil filaments are bulk loaded into a vibratory bowl feeder, sorted, and fed one at a time to the inserting position shown in the sketch. At this position tooling picks up each filament, stretches it, rotates it to a vertical position, and positions the ends of the filament within the hooks on the two lead wires. Then the tooling closes the hooks on the filament ends so that the filament is securely clamped into the assembly.

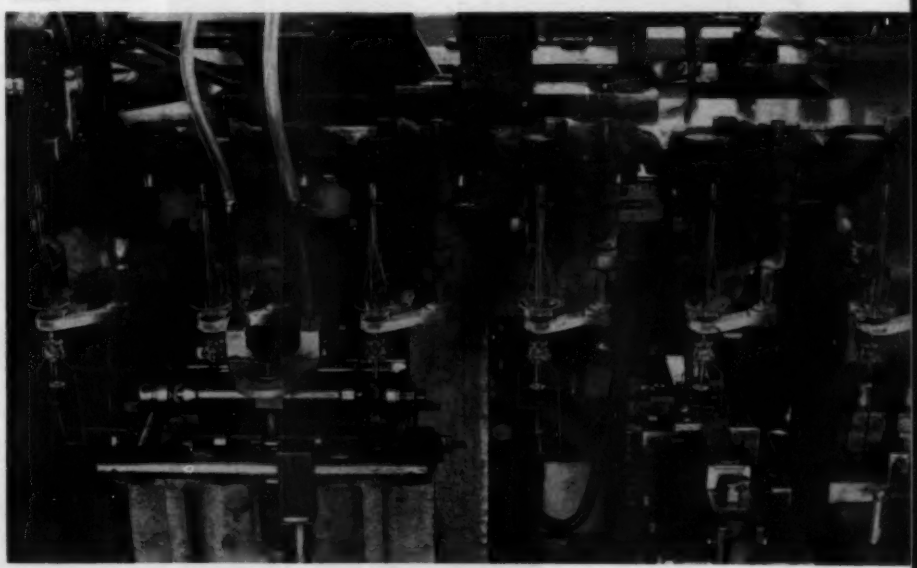
packed into cartons on an automatic case loading and sealing machine.

In the illustrations, the system is tooled to produce 100-watt Eye Saving lamps containing vertical filaments. With the development of the vertical filament in recent years, it became feasible to use one size of glass bulb for lamps of 50, 60, 75, and 100 watts. Machine changeover for producing any of these lamp wattages is relatively simple since the filament supply is the major change. However, the system can also produce other sizes of lamps, such as ones with conventional globular bulbs, with additional downtime for changeover.

An incandescent lamp contains three major elements—a stem and mount assembly which supports the filament, a glass bulb, and a metal base. Each stem and mount assembly consists of a glass flare, a glass exhaust tube, two lead wires, two tie wires, one filament support wire, and one tungsten coiled-coil filament (coiled-coil means that a straight wire is first formed into a coil and then the coiled wire is coiled again). With the exception of the tie and support wires which are supplied from spools, the parts are prepared away from the production system and are fed into the stem and mount machine at the proper point of assembly. Of interest are the lead wires used in the lamps. These wires consist of three different wires which have been welded together, and each lamp uses two types of lead wires. One type has nickel wire on the inner end of the lead, Dumet wire (Ni-Fe core coated with copper) in the middle where glass will be pressed around the wire to create a seal, and copper wire on the outer end of the lead. The other type of lead wire is of similar construction except that a manganese nickel wire is used in place of the copper outer end and acts as a fuse for the lamp.

During the assembly of mounts on the stem and mount machine, the glass and metal parts are indexed though a series of gas burner positions which

5 After turning the corner of the machine, the assemblies are again on the loading side. At the first position on the far left can be seen the stretched filament hooked between the lead wires. Immediately below this position is a chute into which assemblies having missing parts are automatically ejected. In the next two positions a tie wire is curled around each of the lead wires, and the results of this operation can be seen in the fourth position. In the fifth and sixth positions the support wire is formed and curled around the center of the filament. The completed stem and mount assemblies are then unloaded to a conveyor for transport to the sealing-in machine.



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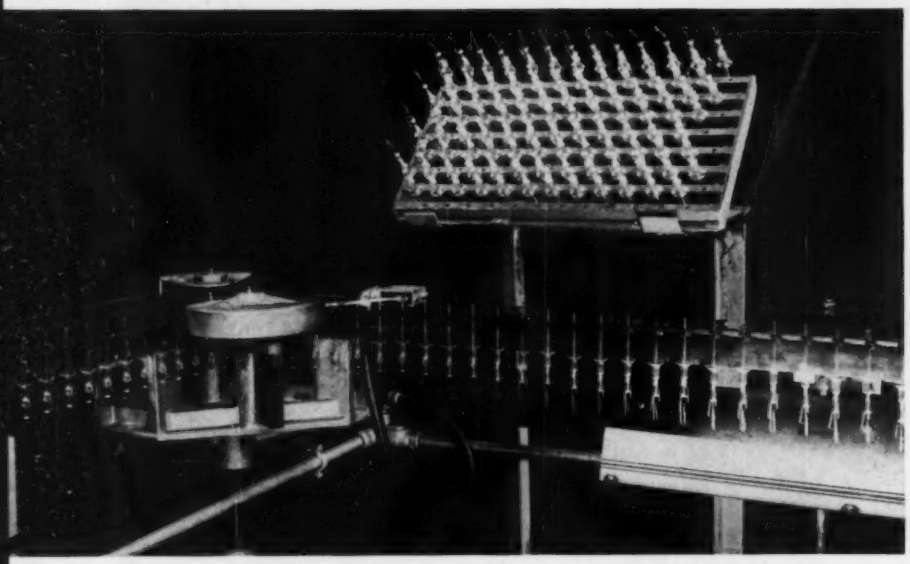
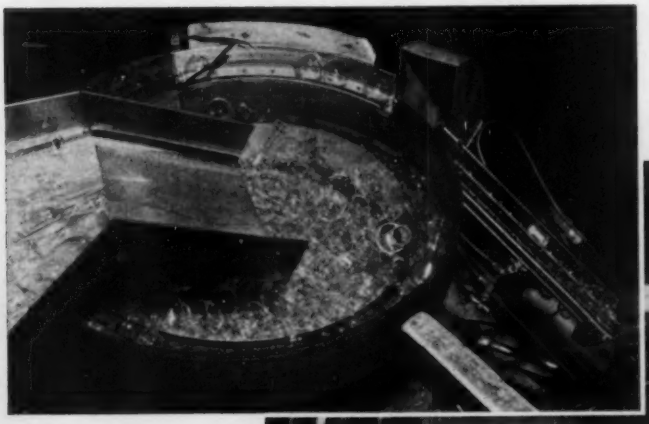


A chain conveyor is used to transfer completed stem and mount assemblies to the sealing-in machine where the bulb and mount are joined together. At one point along this conveyor, out of the picture to the right, the filament is automatically dipped into a red phosphorous getter which vaporizes when the lamp is first lit and chemically reacts with any residual oxygen remaining in the lamp after evacuation and sealing. Minute parts of oxygen in a completed lamp will cause the filament to burn out at a faster rate than normal. The tray above the conveyor in this view holds accepted mounts which are used to replace defective mounts spotted by an operator stationed at this position.

soften the glass so that pressing tools can form the glass support structure for the filament. Of interest in this particular production sequence is the final pressing operation in which a production code is molded in the glass. On one side of the structure, a letter is pressed representing the plant at which the lamp is made. On the other side of the structure, a two-numeral code (July 1961 would be 71) is pressed to indicate the month and year of manufacture.

7

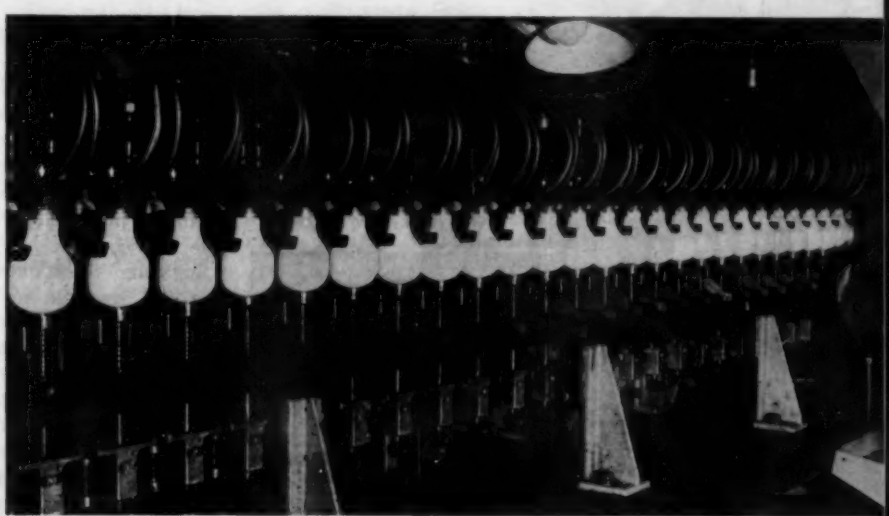
At the opposite end of the 70-foot line the glass bulbs are being prepared for joining with the mounts. Clear glass bulbs are bulk loaded onto a conveyor and fed to a vibratory bowl unscrambler (inset). The bulbs are oriented and fed to a sloping track, at right of unscrambler bowl, from which they are escaped into a horizontal feeder and released into a series of slides. The bulbs are then escaped from the slides into a loading unit for an electrostatic silica coating machine, main view. In this machine a smoke of finely divided silica powder is charged at high voltage and electrostatically deposited onto the inside surfaces of the clear glass bulbs. Density of the coating is controlled by a photoelectric cell which actuates a smoke control valve. After coating, the bulbs are conveyed to a monogram unit where wattage, voltage, name, company, and trademark are etched on top of the bulb. The bulbs are then conveyed to the sealing-in machine.

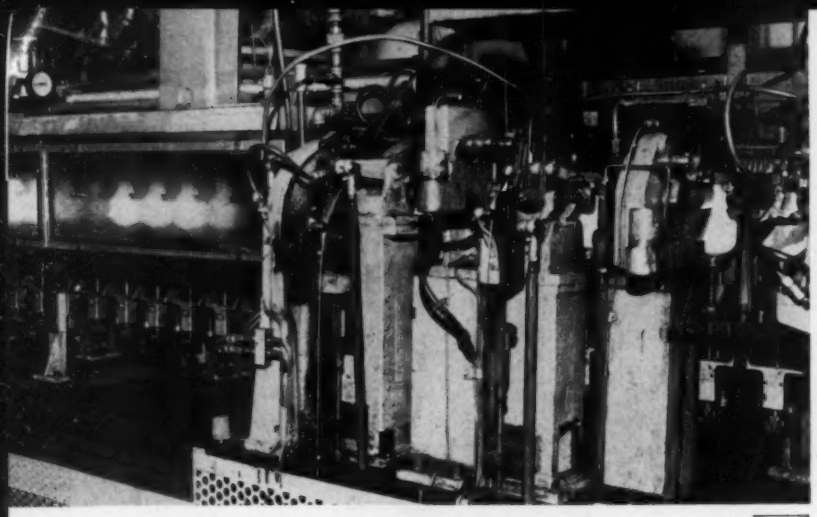


8 On the sealing-in machine coated bulbs are first conveyed through a baking oven to remove residual moisture from the coating. Stem assemblies are picked up from the chain conveyor, *Fig. 6*, inverted, and lowered into spindles of the sealing-in machine. Then bulbs are transferred from the oven conveyor and on the spindles over the stem assemblies. As the assemblies are rotated, a series of fires, shown, heats the bulb glass and forces it against the flare glass to effect a seal between the bulb and flare. At the fourth spindle from the left, cutoff fires aimed just below the sealing point cause the skirt of the bulb or cullet to separate and drop away from the bulb. The bulbs then pass through a molding position where split molds close on the base of the bulb to form it into the configuration of the metal base. The bulbs are then transferred to a rotary table where air is exhausted from the bulb through the exhaust tube, the bulb is flushed with nitrogen, and backfilled with argon gas. After filling, the exhaust tube is heated and tipped off to hermetically seal the lamp.

The exhaust tube of the stem and mount assembly is used for two purposes, both occurring on the sealing-in machine. In one case, after the stem and mount assembly has been positioned and sealed inside the silica coated bulb, it is necessary to mold the bottom of the bulb so that it will fit into the metal base at a later stage of assembly. This molding is accomplished by flame-heating the bottom of the bulb and then indexing the bulb between split mold halves. After the halves are closed on the base, air is blown through the exhaust tube, causing the glass to expand into the contours of the mold. In the other case, the exhaust tube is used as a means of purging the bulb prior to final sealing. First, air is exhausted from the bulb through the tube, and

9 The partially completed lamps are next transferred to the basing machine. The bases have been previously formed from aluminum, filled with a cement that will not set with reasonable exposure to air, and bulk loaded into a vibratory bowl feeder. Tooling on the basing machine first bends and aligns the outer ends of the lamp lead wires to receive the bases. Then, as each base is escaped from the vibratory feeder, it is threaded over the center lead wire, which comes through an eyelet in the bottom of the base, and over the second lead wire which is guided between the base and bulb. The lamps are then indexed past a series of fires shown in this view, which play on the base and cause the cement to set.



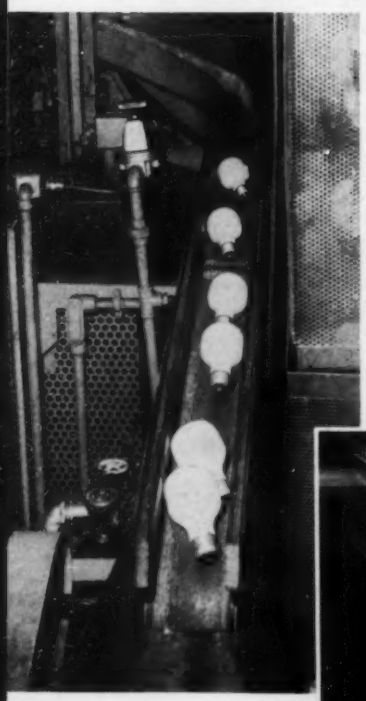


10 On the opposite side of the basing machine final assembly operations are accomplished on the lamps. As the lamps are indexed from right to left, automatic tooling clips the lead wires to length and solders the respective lead wires to the eyelet of the base and to the side of the base. Final operation is the stamping of a price on each lamp. The lamps then are indexed through a flashing or seasoning operation shown in the left of the picture. When each lamp is first lit, the getter on the filament vaporizes and absorbs any residual oxygen. It also sets the crystalline structure of the filament. In other positions, the lamps are again lit for automatic inspection, and defective lamps are automatically rejected.

the bulb is flushed with nitrogen. Then the bulb is filled with argon gas to a pressure of 600 mm (approximately 11.6 psi). When the lamp is placed into service, lit, and is creating heat, the inside pressure of the lamp will be equal to atmospheric pressure, preventing explosion or implosion of the bulb in case of breakage.

The automatic sleeving machine was specially developed by Westinghouse engineers. Two lamps are first automatically loaded into a sleeve, and then a second sleeve is inserted over the first sleeve to completely enclose the lamps and prevent them from dropping out of the package during handling. The packaged lamps are then conveyed to an automatic case loading and case sealing machine where they are packed into either 12-sleeve cartons or 60-sleeve cases.

11 This view shows completed lamps being conveyed from the basing machine. All characteristics that may be inspected automatically have been checked by the multimachine system. However, visual inspection is necessary at this point for such standards as appearance, legibility of price marking, and other details. The lamps are then conveyed to an automatic sleeving machine where they are double wrapped as shown in the inset. The packaged lamps are then conveyed to another packaging machine where they are loaded into cartons, and the cartons are sealed for shipment.



Throughout the production system, many control devices are used to prevent the waste of parts and to actuate rejection mechanisms for defective assemblies. In some cases, controls are used to detect the presence or absence of any part or assembly with which it is to be joined. This is accomplished by a synchronizing system that postpones feeding of subsequent parts until complete assemblies are possible. Other devices are required due to the nature of the process, that is, when a machine using flame on glass is stopped, all parts in process must be completed to prevent glass melting and causing damage to parts and equipment. Therefore, when the control system calls for stopping a machine, the parts in process are allowed to continue being worked on until the last part has moved out of the machine.

On the sealing-in machine control devices coordinate the feeding of bulbs and stem and mount assemblies so that if no bulb is available for assembly, no mount will be fed; if no mount is available, no bulb will be fed. This control requires anticipatory circuits due to the difference in the number of positions between where the parts are fed and where they meet for assembly.

Experience has indicated that the uniformity of quality produced by the automated production system is considerably improved over previous manufacturing techniques. However, human inspection is still required for many visual types of defects. Operators also make statistical quality control checks of the operating machines at frequent intervals to ensure that the system is functioning correctly. They check such items as the turns per inch of the tungsten filaments, density of the silica coating, gas pressure in the lamps, stem straightness, etc. Results of these tests are plotted on control charts so as to keep the process operating within 3 sigma limits.

Fig. 1—Automatic system performs tests on static and transient parameters of computer logic circuit cards. Cards are placed in the card loader (at right) and automatically indexed along either of two parallel tracks. Under control of the information unit (at left background) the cards are tested at 18 stations and ejected to bins under the stations if test results so indicate.

CIRCUIT CARDS TESTED AUTOMATICALLY

This system to test printed logic cards was developed to meet demands for increased production, improved accuracy, and higher reliability. Cards are automatically indexed past test stations which use plug-in test circuits and program boxes to check static and transient parameters. Quality control information and manufacturing acceptability are sensed, with provision for automatic ejection.

By **HAROLD A. SEAMAN**, Associate Engineer, International Business Machines Corp., Poughkeepsie, N. Y.

AUTOMATIC TESTING machine at International Business Machines Corp. performs testing functions for both the manufacturing group and the quality control group. It supplies go—no go testing for the manufacturing group, and measurements of variables of each card tested for the quality control group. Testing at a rate approximately five times faster than the former manual method, it also achieves a higher degree of accuracy and reliability than that method.

The machine described in this article, *Fig.* 1, is one of a series of automatic testers designed by IBM engineers in a long-range program to fulfill requirements of both manufacturing and quality control in integrated systems. A chief feature of the system for quality control purposes is its provision for accumulating measurement data on each transistor circuit card tested. Individual evaluation, as opposed to batch evaluation, may, therefore, be accomplished.

This machine is designed to test computer logic circuits that consist of phenolic boards with printed wiring on one side and circuit components on the other. In use the cards are inserted into a panel; several panels comprise a unit; and several units

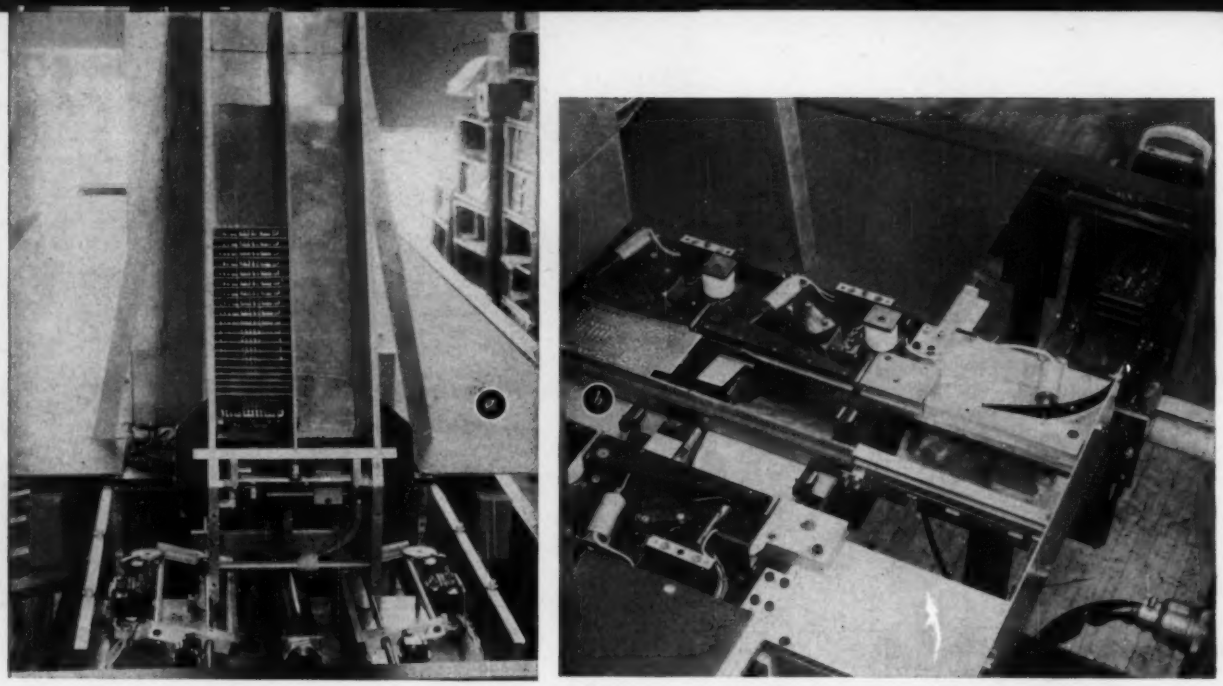


Fig. 2—Closeup views show feed end *(a)* and discharge end *(b)* of handling unit for card testing. In the view of the feed end *(a)* only the loader for the left track is shown with cards in place to be escaped to the track. Below each side of the loader is a push rod which advances cards through the machine. A pulley on a vertical rod swings a yoke on the push rod to swing fingers along the length of the track into and out of engagement with the cards being indexed. The photograph of the discharge end *(b)* was taken with elements above the last two test stations removed for better visibility. The final eject station is at right. The card in the test station is shown with its terminal end lifted as it would be to contact the test circuit contacts. On command, the small horizontal solenoids swing the pivoted sections of track to eject cards to the chutes below. The mechanism at upper right places cards directly into a shipping magazine.

may be included in a single computer.

The tester, called the automatic transistor card analyzer, was particularly intended for testing current switching diffused-base transistor printed card circuits. It tests and evaluates the drift current-mode family of logic circuits which use high-speed, diffused-base transistors. However, due to the use of test circuits in the form of plug-in modules and other versatile design features, this tester can readily be converted to test most existing circuit families.

The three basic elements of this machine are an information unit, an automatic card handler, and plug-in boxes for test circuits and programs. The information unit contains the system controls, power, and operating logic. The card handler is the transport mechanism and provides a card loader, eject mechanisms, a power distribution raceway, and mounting facilities for the test circuits and program boxes. The card handler includes two tracks for cards to be tested, with 18 test positions along each track. The pluggable test circuits and program boxes, one of each being required for each test position, complete the system.

Because of the huge quantities of printed card circuits required in computer manufacture, the system was designed and built on an accelerated schedule. Three teams of engineers worked simultaneously on the three basic elements of the machine. Each team was kept thoroughly informed of the developments of the other two.

The configuration of the machine had to be designed to accommodate exceedingly fast switching time. Wiring capacity, noise generation, etc., had to be minimized. This led to the plug-in test circuit concept, which affords minimum lead length and excellent shielding. It also makes the system virtually obsolete-proof since any device may be tested if it can be transported and if a test circuit can be designed for it. The sequence of tests is somewhat arbitrary, but in general it was felt that the static tests should be performed first to guarantee that each card was properly constructed and that the components were at least operating. Then the transient tests are made.

▶ Over-all Operation

After being stacked in the card loader, the printed circuit cards are automatically fed through the handler. Fingers on pneumatically operated push rods move them along the track of the handler to the various test positions. At the test positions the cards are lifted by pneumatically operated push rods for physical contact with the card contactors of the test circuits. Voltage is applied to the cards, and the

test circuits receive the command from the information unit to start testing. After a stabilization period, each station is interrogated by the information unit for the test results, which are then compared to programmed limits for the particular station.

Circuit cards successfully meeting the prescribed requirements are transported along the handler track to the next position for a succeeding test. Cards failing to meet the requirements are automatically ejected at each station. A card is ejected when the track section at the station pivots away from the card and permits it to drop into a bin beneath the track.

The testing procedure is protected against error. Each mechanical operation is interlocked and sensed so that any malfunction in the feed cycle will be detected and cause the machine to stop. The voltages applied to the circuit cards are carefully monitored, and voltage variations outside the preset range are detected and indicated. An error-detection circuit has also been included in the operating logic of the test result encoding circuit.

▶ Card Handling

Cards are manually stacked in the loader mounted at the feed end of the handler, *Fig. 2a*. Upon commands from a feed cycle sequencer, the loader releases a card every six seconds. A small air cylinder activates a linkage mechanism which, in turn, rotates six rods, each of which has two pads attached 90 degrees apart. During the first part of the stroke the rods rotate to permit the upper pads to pass the bottom card in the stacker to the lower set of pads. The upper set of pads have, in the meantime, blocked the next card. On the return storke the first card is released and enters the first station and the next card is positioned for release.

The cards are indexed along each track in the handler by fingers mounted on a rotatable push rod. The rod is rotated about 45 degrees by an air cylinder to bring the fingers into position to engage the cards. Another air cylinder then advances the rod to index the cards forward to the next station. The rod is then rotated to lower the fingers and is retracted to its original position.

At each station, *Fig. 2b*, there are card stops against which the push rod positions the cards. Each stop is lifted by an electromagnet to permit passage of cards during indexing.

After the cards are properly positioned, the terminal end of each card is raised by a lifting rod operated by an air cylinder. This brings the 16 terminals of the card against contacts wired to the test circuit and program box above that station on the track. The desired test is then performed under the control of the information unit.

MEASURING CIRCUIT DELAY

PLUG-IN test circuits are used in the automatic transistor card analyzer developed by engineers at IBM. One of the basic test circuits is that to check card circuit delay. Operation of this test circuit may be more readily understood by reference to the accompanying block diagram. The Multivibrator produces a symmetrical square wave 12 volts in amplitude with a frequency of 100 cps. This is fed to the Reset Pulse Delay and the Relay Driver. The Relay Driver consists of mercury relay contacts and associated circuitry, which pulse both the Delay Cable and Card Circuitry and the Fast Ramp Generator.

The Fast Ramp Generator converts the mercury relay pulse input to a minus 12 volt pulse with a linear rise time of 100 milli microseconds. This linear rise time pulse, in turn, is fed to the base of the first avalanche transistor in the Strobe Pulse Generator.

The Strobe Pulse Generator consists of two cascaded avalanche transistors and associated circuitry. The two transistors are held in collector breakdown. The fast ramp input to the base of the first transistor throws it into avalanche breakdown so that the collector shifts from collector breakdown (approximately minus 40 vdc) to avalanche breakdown (approximately 0 vdc) in a matter of milli microseconds. This shift is fed to the base of the second avalanche transistor and throws it into avalanche breakdown. Because of the larger and faster input shift, the second transistor goes into breakdown faster than the first. The collector shift of the second transistor is differentiated to form the sampling or, as it is called, the strobe pulse. At input this pulse is about 2 volts in amplitude and about 3 milli microseconds at the base. It is fed to the Mixer.

Also fed to the Mixer is the pulse output of the printed circuit card under test. It is fed to the Mixer through the Delay Cable and Card Circuitry, which has accepted it as a fast rise input from the mercury relay contacts. The Delay Cable and Card Circuitry decreases the rise time to accommodate the card pulse with an input pulse rise which is similar to the inputs in machine environment. Before being fed to the Mixer, it is converted from minus 12 volt shift to minus 6 ma machine current pulse.

The Mixer accepts the card output pulse and the strobe pulse, attenuates them, and sums them. At the summing junction the amplitude of the card pulse is 0.5 volt and that of the strobe pulse is minus 0.7 volt. The mixing circuit determines when the strobe pulse has arrived at any preset point on the transient of the card pulse.

The diode Detector presets the bias level. The strobe pulse is advanced in time and eventually moves up the transient of the card pulse. As the strobe pulse moves, its peak negative value below ground diminishes. At one point the peak will become smaller than the negative bias on the diode, resulting in zero input to the Sense Amplifier.

The Sense Amplifier increases the width of the sampling pulse so that it will be easily observable. The process consists of two stages of amplification and a single-shot output stage. The narrow low voltage input pulse (100 milli microseconds, 300 millivolts) is increased both in width and amplitude so that the output is a pulse approximately 5 microseconds wide and 6 volts in amplitude. This pulse is

If a card is to be ejected as the result of the test procedure at any station, a solenoid is energized at that station. The solenoid pivots a section of track away from the circuit card a distance sufficient to allow the card to drop into a chute. The chute guides the ejected card into a bin below the station.

A terminal box at the end of the handler contains all the fusing, voltage monitoring circuitry, and cable connections. This box serves as the cable terminus between the card handler and the information unit.

Plug-In Station Boxes

The test circuits, *Fig.* 3*a*, which are plugged into the stations of the card handler are used to measure the static and transient parameters of the printed circuit cards. These tests include short circuit detection and measurement of output level, circuit delay, rise time, and stability.

Short circuit detection is performed by a test circuit which determines whether or not an error in the manufacture of the card will cause a short circuit. A test circuit for output level measures the output levels in a quiescent state.

Circuit delay is defined as the time elapsed from the 10 per cent point of the input pulse to the 10 per cent point of the output pulse. The test circuit to measure this delay is described in the accompanying box titled "Measuring Circuit Delay."

Rise time is defined as the time elapsed from the 10 per cent point of the output waveshape to the 90 per cent point of the same waveshape. The test circuit to measure this time period uses the circuit delay circuitry and additional circuitry.

Stability is measured by a test circuit using a diode detector and wide-band amplifier with additional logic circuitry. It tests percentage overshoot, pulse amplitude, and noise in one combined test.

The plug-in program boxes, *Fig.* 3*b*, supply the proper connections to the test circuits and supply load circuits when needed.

Information Unit

Over-all control of the testing and evaluating procedure is performed by the information unit. A simplified block diagram of the evaluation function is shown in *Fig.* 4. Evaluation of a printed circuit card is based on the limits preset into the program switches (located in the information unit) for each station. The program switches are manually operated rotary switches that return a binary coded 1-2-4-8 signal for a decimal setting. Each switch contains six sections, thereby providing two 3-digit numbers—one representing a high limit, the other a low limit.

Evaluation begins with the feeding of test signals fed to the Memory Amplifier, which responds to both it and the Reset pulse from the Reset Pulse Delay.

The Reset Pulse Delay accepts a square wave output from the Multivibrator, and generates a negative pulse of 12 volts in amplitude from the positive swing of this square wave input. In addition, its output pulse is delayed about 2 milliseconds from the input swing. This delay insures that the pulse will arrive at the Memory Amplifier 1 millisecond before the pulse from the Sense Amplifier. The delay is necessitated by the input requirements of the Slow Ramp Generator.

The Memory Amplifier is a two-transistor bistable circuit that latches at either ground or minus 6 volts. The Set pulse from the Sense Amplifier latches the output of minus 6 volts; the Reset pulse from the Reset Pulse Delay latches the output at ground. Under start-of-test conditions the output stays at ground for 1 millisecond and at minus 6 volts for 9 milliseconds. This output is fed to the Slow Ramp Generator.

The Slow Ramp Generator consists of three transistors and associated circuitry. It converts the pulse input from the Memory Amplifier to either a positive or negative slope ramp. Its output will seek ground when its input is at ground; and its output will seek plus 10 volts when the input is at minus 6 volts. With the input at start-of-test conditions, the output will be a positive slope ramp of 5 volts per second. This slow ramp output is fed back to the base of the first avalanche transistor of the Strobe Pulse Generator.

At start-of-test the slow ramp input to the Strobe Pulse Generator is at ground, and the strobe pulse is at the Mixer summing junction simultaneously with the 10 per cent level of the input pulse to the card under test. The output of the Memory Amplifier is at ground for 1 millisecond and at minus 6 volts for 9 milliseconds.

Testing is begun by the closing of the starting relay contact, which connects the Memory Amplifier to the Slow Ramp Generator input. The sampling process results. The slow ramp begins its ascent to 10 volts at a rate of 5 volts per second and is fed back to the first avalanche transistor of the Strobe Pulse Generator. Its effect is to delay the strobe pulse by one milli microsecond for each 100 millivolts of the slow ramp pulse, or at the rate of 50 milli microseconds per 5 volt change in the slow ramp pulse.

The strobe pulse moves in time until it reaches the preset point in the rise of the card pulse. When it arrives at this point, there is no input to the Sense Amplifier from the Detector and no Set pulse to the Memory Amplifier. The output of the latter remains at ground, causing the Slow Ramp Generator to go towards ground. As the Slow Ramp Generator goes to ground, the next strobe pulse moves down from the preset level of the card pulse, supplying an input from the detector to the Sense Amplifier and a Set pulse to the Memory Amplifier.

The output of the Memory Amplifier stays at ground for 10 milliseconds, the time between strobe pulses. The output then shifts to minus 6 volts, causing the slow ramp to increase toward plus 10 volts. The process repeats and results in a hunting of the strobe pulse about the preset point on the card pulse. The readout is taken as the value of the slow ramp voltage at null, which is any point after the slow ramp and strobe pulse have begun hunting.

from the test circuits to a scanner. The scanner consists of *Stations On* relays. Upon commands triggered by the feed cycle, 19.5 cps clock pulses are gated to the *Stations On* triggers, which are connected to form a Leslie ring. Each *Station On* trigger energizes the relay and gates the result register for its particular station. Each relay connects the test circuit output for its particular station to the digitizer input; prevents digital conversion until the voltage amplifier has stabilized; prevents the succeeding *Station On* relay from energizing prematurely; and supplies the gating pulses to the program limits switch for its station.

Conversion of the test circuit output voltage to a 3-digit, 4-bit binary-coded number is accomplished by the digitizer. The coded digitizer outputs are converted to supply binary information to the adder.

Acceptance or rejection of the printed circuit card under test is based on the results from the subtraction of the numbers representing the test circuit operation and the numbers preset into the program switch for the particular station. The arithmetic takes place in a binary adder circuit. The actual operation is a subtraction by the addition of complements. The adder circuits recognize whether the converted and recoded number from the test circuits is equal to or less than the high limit and greater than the low limit of the preset program switches.

The binary coded test signal to be presented to the adder is in the form of a 1-2-2-4 configuration. Program switch information, however, is in the form of a 1-2-4-8 bit configuration. The converter output, properly referenced, must therefore be recoded so that the arithmetic of the adder may take place. Recoding of the converter information is accomplished by the code translator, a configuration of logical circuits designed to perform this function.

▶ Timing

To accomplish the timing of the arithmetic cycle, a single-shot circuit delays the adder approximately 15 milliseconds. This allows the timing gate generator trigger to be turned on and permits the 625 cps clock pulses to enter the timing gate triggers. Like the *Stations On* triggers, the timing gate triggers are connected to form a Leslie ring. The resultant pulses are used as follows:

TG-0—A dummy timing gate to permit synchronization of the timing gate generator and the timing gate clock pulses.

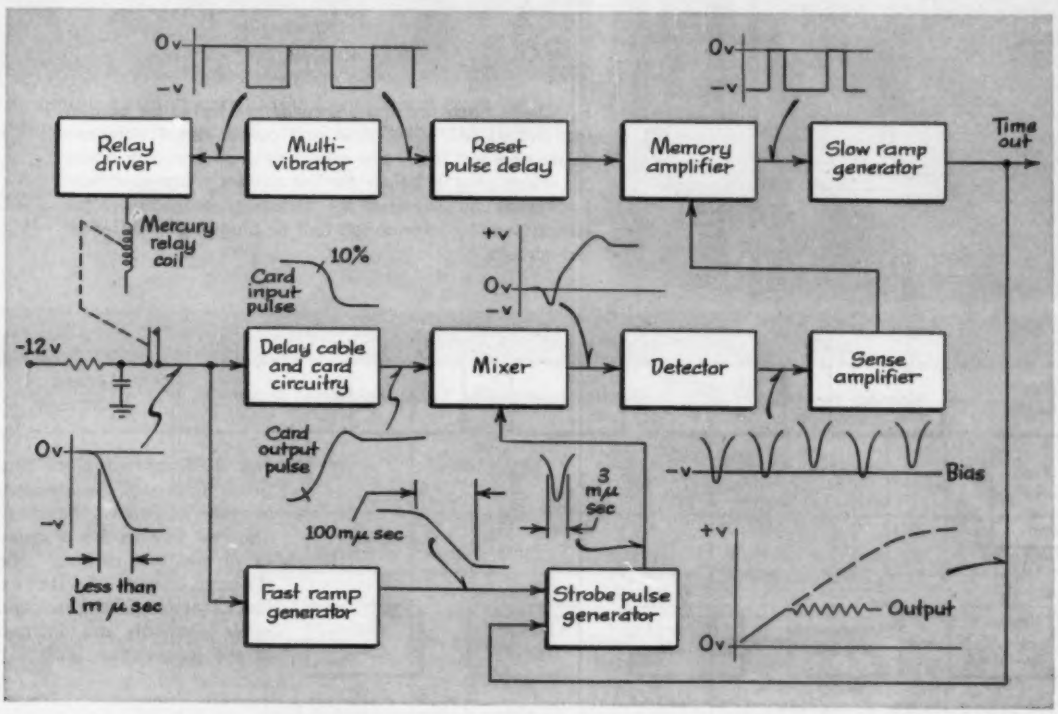
TG-1—Gates the high limit program setting to the adder.

TG-2—Gates the adder output to the high limit latch.

TG-3—Gates the low limit program setting to the adder.

TG-4—Gates the adder output to the low limit latch.

TG-5—Gates the output of the high and low limit latches to the result register bus.



Block diagram indicates operation of plug-in test circuits in checking delay time of transistor card circuits.

TG-6—Causes the carry trigger, the latches, and the timing gate circuit to reset.

The adder output terminates in a binary trigger whose outputs are each connected to a latch circuit. If no carry has resulted in the arithmetic cycle during TG-1 time (signifying that the result is equal to or less than the high limit), TG-2 and the *Off* side of the carry trigger turn on the high limit latch. If a carry results during TG-3 time (signifying that the result is greater than the low limit), the carry trigger will be turned on and in combination with TG-4 time will turn on the low limit latch. At TG-5 time (if both limit latches are on), the result register trigger for the particular station will be turned off, indicating a successful test. Should either limit latch be off, the result register trigger will remain on, indicating a test failure.

▶ Card Ejection

Each station has an eject mode switch preset to determine whether or not a card shall be ejected if the test at that station is unsuccessful. This mode switch is set for either *Accept* or *Reject*. A card is to be ejected if the station mode switch is at *Accept* and the test has been successful. When the mode switch is at *Reject* and the test is unsuccessful, the card is to be ejected.

With the completion of the *Stations On* cycle, the result register contains the results from the arithmetic cycle of each station. The card eject cycle is then activated by the feed cycle sequencer. The eject cycle begins with an interrogation of the result register and the eject mode switches.

When called for, card ejection is accomplished by energizing the solenoid which pivots a section of track at the test station. The pivoting of the track section operates a track sensor switch, which, in turn, sets a latch circuit. At the conclusion of the card eject pulse, the track sensor latches and the card eject lines from the result register are compared. Any discrepancy in the comparison causes the machine to stop.

Cards which are not ejected at any of the test stations are discharged from the track at a final eject station. A mechanism at the final eject station places the cards directly into a shipping magazine.

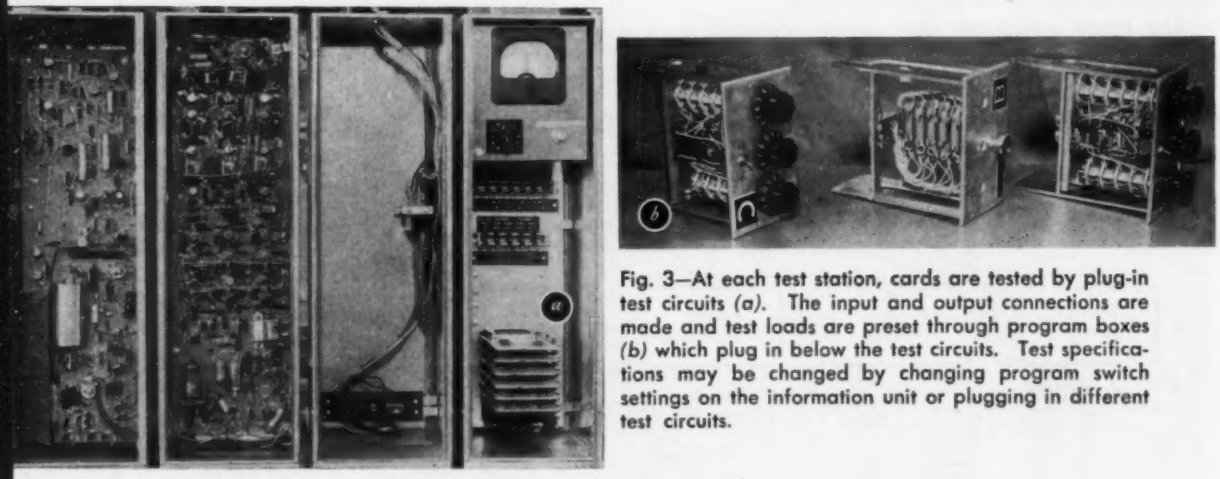


Fig. 3—At each test station, cards are tested by plug-in test circuits (*a*). The input and output connections are made and test loads are preset through program boxes (*b*) which plug in below the test circuits. Test specifications may be changed by changing program switch settings on the information unit or plugging in different test circuits.

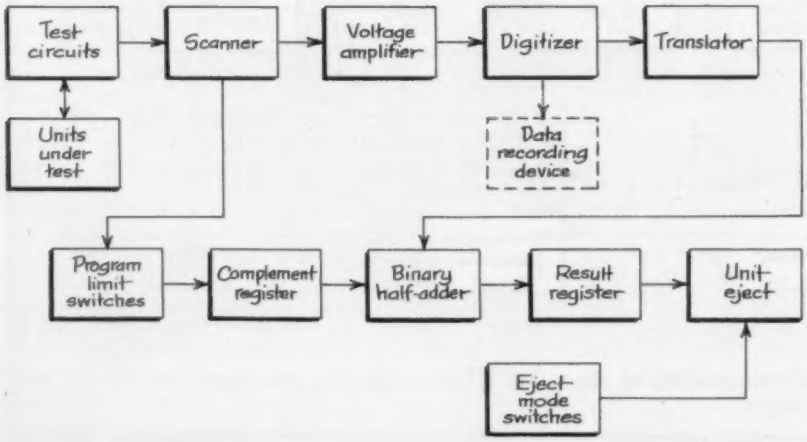


Fig. 4—Simplified block diagram illustrates the elements in the evaluation function. The Test Circuits are plugged in at the test station. The Program Limits Switches, Eject Mode Switches, and other elements are located in the information unit.

MONITORING, LOGGING, AND CONTROL WITH DATA

Equipment for automatic manufacturing is generally divided into three classes: 1. Process. 2. Handling. 3. Control. To truly integrate the various steps of the process with each other, and with the handling and control gear, involves use of data systems. Techniques being applied to various process industries have potential application in all manufacturing industries.

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SINCE the industrial revolution, plants of all sizes—small, medium, and large—have had degrees of automatic manufacturing equipment systems coupled with manual data handling systems. Major advances are being made in both equipment systems to increase production and in data systems to better control production and to better inform management of operations. These advances are gradually leading to full automatic control of business.

A production cycle begins with an input of information—a customer's order—and ends with an output of product—the shipment of finished goods. In applying automation to this cycle, we must be able to integrate materials handling with materials processing and to control the equipment and machinery effecting the integration. During this production cycle, considerable management control data are available, and in applying automation we must also think in terms of integrating information handling with information processing so as to provide management with accurate, up-to-date control information on the production cycle. Therefore, a complete system of automation should include integrated and controlled processing equipment and machinery and integrated and controlled data handling systems that permit management to keep its finger on the pulse of the production processes.

The end result of this continual integration between management and manufacturing will be computer control of processes. For example, according to *Business Week* (November 5, 1960), "At an accelerating pace, the machines are taking over the ultimate job of production supervision . . . They have made greatest headway in steam-electric plants and in the processing industries, such as oils and chemicals. There, computers have taken over control of entire

This article is based on a paper presented at the "Fifth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and the Manufacturing Engineering Council, April 1961.

TABLE 1—Application of Computers in Process Industries

Process Industries	Computer Operations	Sensors	Controlling	Key Process Variables	Reason for Buying
Electric Utility	Many Programs with Many Steps	Many, Historic	Many, Simple	Customer Demand	Service
Steel	Mathematical Equations Fewer Details Rapid Decisions	Fewer, Much Further Development	Fewer, Moderate Difficulty	Compositions and Shapes	Performance
Chemical	Complex Equations Many Calculations Predictions	Few, Much Further Development	Few, Recent	Rate of Reaction	Safety and Yield
Petroleum	Many Numerical Calculations	Few, Much Further Development	Few, Recent	Raw Material Octane Demand	Product Mix

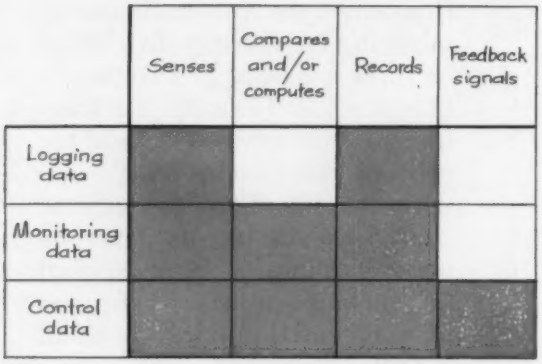

Fig. 1—Chart shows a comparison of various types of data systems. Logging data only senses and records occurrences. Monitoring data senses, records, and compares and/or computes occurrences. Control data originates feedback signals for corrective action in addition to the regular monitoring functions.

plants . . . How far to employ computers is a difficult decision that faces management in more and more industries." However, in many manufacturing industries computer control of processes is an eventuality that will not be reached for many years, and the immediate task for management is to update its present obsolete system of manually handling data.

Information Loops

Embodied in a production cycle are directive information loops and feedback information loops which interact with control gear necessary to move and transform raw materials into finished products. Whether these networks of information handling and material processing are simple or elaborate depends to a large degree on the size of the manufacturing plant—small, medium, or large—and on the influences of the product market which dictate the lot size, mix, and delivery cycle. It is noteworthy that in a small plant the addition of a simple conveyor system is automation to a degree, and sometimes the installation of an elaborate data handling system does not proportionally contribute any more to automation.

The elements of information handling and data feedback are present in every manufacturing and processing system, but the degree that these elements have been developed and used in various industries varies widely. For example, manufacturing industries have emphasized equipment systems for the automatic manufacturing of a product, but have generally ignored the importance of information handling and data feedback from manufacturing to management in the over-all automation picture. Therefore, these elements are the weakest links in manufacturing automation. On the other hand, the process industries—utilities, chemical, petroleum, and steel—have developed elaborate systems for information handling and data feedback, and these elements are the strongest links in process automation. The important factor is that much of the excellent data hardware and concepts of the process industries can be applied to the manufacturing industries.

The process industries are concerned with information handling and data feedback in the control of two types of production—continuous flow and batch lot. By the same token the manufacturing industries are concerned with analogous types of production—large lot and job lot. The same basic systems solution to continuous flow processing can be applied to large lot manufacturing, and, similarly, batch lot processing solutions can be used for job lot manufacturing. Both industries use process equipment to make or perform work, handling equipment to move or transport, and control equipment to regulate. For example, in a process industry the reactors and distillation columns make the product, the pipelines transport the product, and analog controllers regulate the process. In a manufacturing industry the machine tools make, the conveyors transport, and numerical controls regulate.

Information handling and data feedback systems are applicable to both industries, and in the process industries these systems have stepwise progressed from simple automatic logging to complex control. Wide use of automatic logging, wide use of monitoring, and limited control are now being used. Ultimately, these systems will lead to computer control, TABLE 1. As recently pointed out in *Fortune* (December, 1960), "Now a number of U. S. companies are taking the penultimate step toward complete automation at all levels, from the production line on up . . . They have installed computer process control (CPC) to take charge of some of their pro-

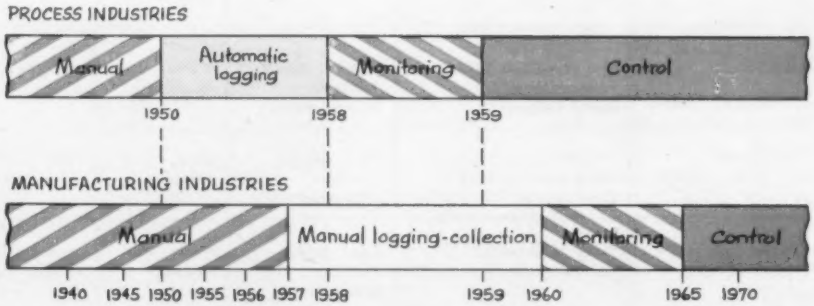

Fig. 2—Historical development of data systems in process and manufacturing industries is shown in this chart. Where the process industries are now in the early stages of process control by computer, the manufacturing industries are not expected to reach this stage of data handling for at least 5 to 10 years.

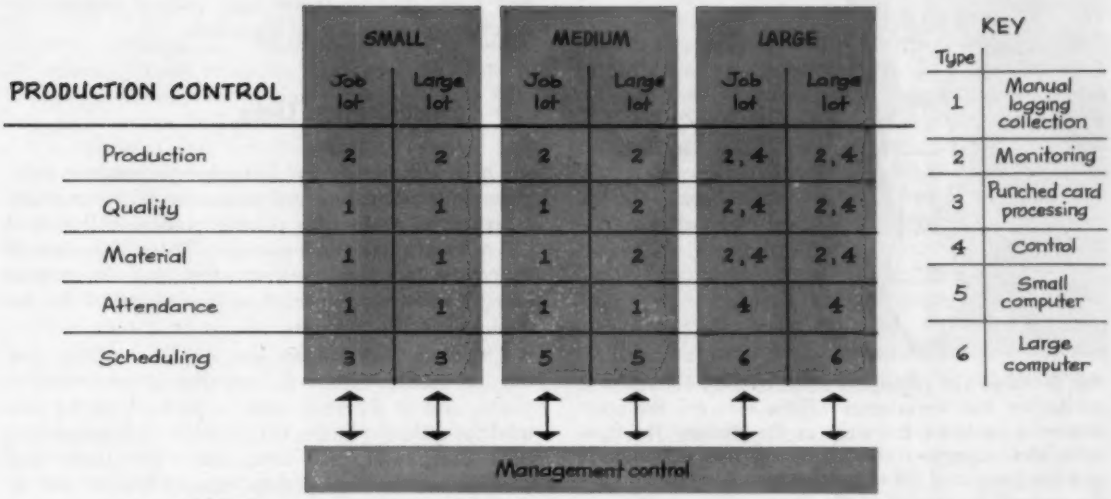

Fig. 3—Small, medium, and large manufacturing systems can apply various types of data systems, ranging from manual logging and collection to large computer operations, as shown in this chart. An efficient automatic means of handling data should provide the link between production control and management control.

duction processes. CPC represents a major, and long-awaited, breakthrough in automation. For the first time machines will make operating decisions on their own, and act on them."

The process industries are years ahead of the manufacturing industries in the development and use of information handling and data feedback systems. They have gone through a natural progression of methods from manual to automatic logging, to monitoring, to computer control, *Fig.* 1. Development of these systems has required a wide range of talents with knowledge of industrial processes, instrumentation, automatic controls, mathematics, and computer technology. As the hardware for these systems was developed, the process industries adapted the methods and applied data systems to their processing systems. However, the manufacturing industries are only now beginning to apply process industry data handling techniques, *Fig.* 2.

▶ Data Techniques

At the present time, six techniques for handling data can be applied by manufacturing industries with equipment now available or soon to be available. These techniques include manual logging and collection, data collection and monitoring, punched card processing, control, small computers, and large computers.

Manual logging and collection: Systems using this technique include human operators who log associated data manually and then insert fixed data on prepunched cards and variable data on dials of collection devices on the production floor. Production information is transmitted automatically to a central data collector which supplies management with data feedback depicting shop status for timely decisions and effective action.

Data collection and monitoring: This technique is designed specifically for the control of shop operations. It is designed to automatically collect accurate and well-organized information for payrolls and reports and is an answer to management's requirements for complete, timely, and precise information. Since the system automatically originates and handles all vital manufacturing information, strong centralized control can be achieved. Such a system eliminates paper work on the production floor and automatically generates information for tabulating or data processing.

Punched card processing: This technique accepts production-control data, provides timely management reports, and updates production schedules.

Control: This technique automatically monitors and regulates production according to daily schedules.

Computers: Small and large general purpose computers are available for processing production control data, updating schedules and inventories, and preparing management reports.

The application of these data systems in small, medium, and large manufacturing systems is shown in *Fig.* 3. It is believed that data collection and monitoring systems are of paramount importance today in manufacturing industries for production and management control. There are three key principals in this type of system—the machine operator, the shop foreman, and the work dispatcher, *Fig.* 4.

The machine operator performs the work and is the closest observer and monitor of the job in progress at his workstation. In order to monitor the work and make the necessary adjustments, he must stay on the job. His performance is measured by the number of pieces he produces or the job time. The services needed to keep him steadily on the job must be at his call. Many decisions cannot be made by the operator, but must be made by his foreman,

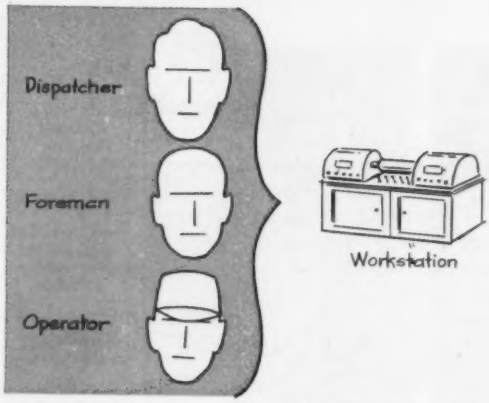

Fig. 4—Three key principals effect over-all control on a production line workstation. These men are the operator who performs the work at the station; the foreman who supervises the operators, the workstations, and the jobs; and the dispatcher who is responsible for the over-all monitoring of the shop.

depending upon the policy of the shop.

The second principal, therefore, is the shop foreman of a group of workstation operators. His major responsibility is to carry out shop orders on schedule. To do this he must select and match as close as possible the operators, the workstations, and the jobs. This requires making decisions to keep these three elements operating steadily and effectively. The foreman must rely on information relayed to him from a production control center, which information has been relayed to the center from the foreman's group of operators, as well as from other important functions in the shop.

The third principal is the dispatcher whose responsibility is the over-all monitoring of the shop. He is the key interpreter of the system information for monitoring the shop. Located at the production control center, where the status of every work station and its shift production record are available at any time, the dispatcher uses various communication links to control shop operations.

Communication Links

Three communication links are necessary to integrate both vertical as well as horizontal communications, to be on-line for control, and to collect data for reports, plans, and payrolls. These links can be called the data link, the status link, and the message link. Monitoring information is transmitted by the data and the status links.

The data link counts and displays in the production control center the number of operations or pieces, and at the same time keeps track of the time used for different modes of operation such as running time, delay time, and setup time. The status link is displayed at the operator control station and at the production control center by means of colored light displays. By a moment's glance at the display, the dispatcher can be provided with an immediate picture of the way the shop is operating. Decisions, based on monitored information, form the basis for the controlled actions in the shop.

The third communication link, the message link, supplies direct messages for control. It can consist of three devices—a telephone network to enable all foremen in the shop to communicate with the dispatcher, a shop paging system so that the dispatcher can send assistance to machine operators, and workstation-to-central message sending light display. Proper use of these devices in the message link direct the shop activities.

General Electric Co. has developed a data collection and monitoring system to integrate the three principals in a shop by means of the data, status, and message links. The GE-3100 or Shoptrol system, *Fig.* 5, is a system designed specifically for controlling shop operations and was created by shop-oriented people for use in all types of shops. The

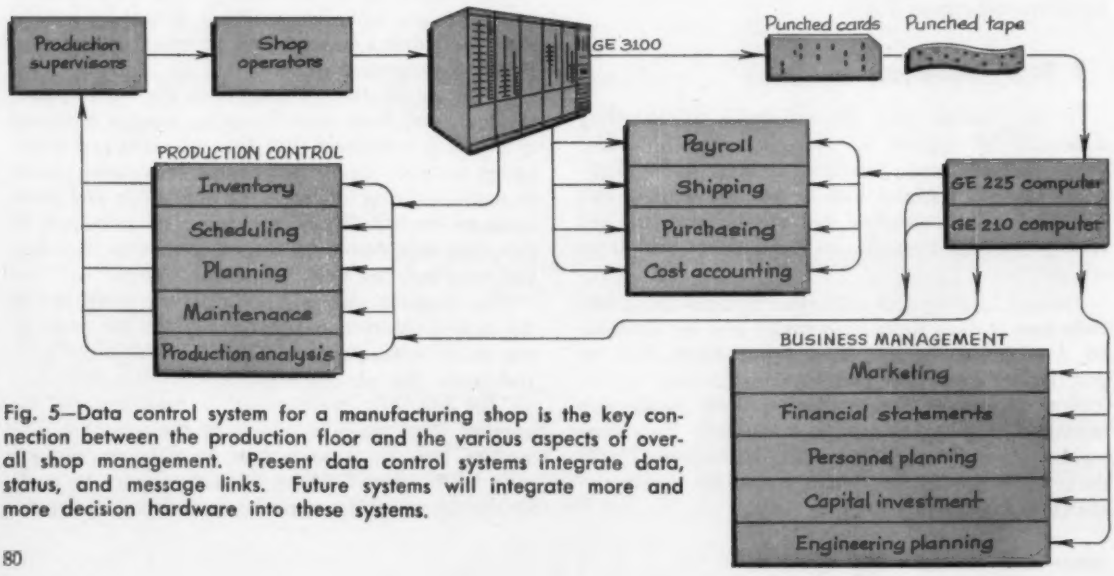

Fig. 5—Data control system for a manufacturing shop is the key connection between the production floor and the various aspects of over-all shop management. Present data control systems integrate data, status, and message links. Future systems will integrate more and more decision hardware into these systems.

operation modes of the data and status links are similar to those already described and provide means for relaying direct messages from the workstations to the production control center and means to feed back and monitor results.

The message link in the Shoptrol system uses three devices for control of operations. The first device is a telephone network and squawk box, located in the production control center, which enables the foremen in the shop to communicate with the dispatcher. Each foreman on the floor carries a handset with him. When he is paged, he can plug the handset into a receptacle at any workstation and talk to the dispatcher. When necessary, group discussions among several of the foremen and the dispatcher can be held.

The second message link device is an Operator Control Station-to-Control Center signalling device. In the production control center are four lights associated with each operator control station. Each light can be *Off*, *On* steady, or *On* flashing. In the steady or flashing states, each light provides two predetermined messages, and all the lights in various combinations provide eight specific messages. An operator control station transmits one of these messages to the dispatcher when a selector switch is turned to the appropriate position.

The third device in the message link is the shop paging system. The dispatcher may speak over this paging system to all points in the shop. This enables him to send assistance or service to a workstation where it may be needed. For example, an operator may need a decision from a foreman, or he may need an inspector, a die-setter, or material. The dispatcher may direct these services to the operator by using the paging device.

Production control sub-system hardware integrates with other hardware and nonhardware sub-systems such as quality control, materials control, etc. The ability to handle information, to process information, and to control is self-evident. Future steps will integrate more and more decision making hardware into these systems. Process industries began with logging and then proceeded to hardware of this type. This is a logical step, and manufacturing industries also can profit from this step. By learning from logging, new insights into the effects of decisions can be obtained through techniques such as simulation.

Progressive steps can be taken today by manufacturing industries which will eventually lead to automatic control of business. These steps include:

1. Vigorously pursue sensor application for automatic data origination.

2. Try manual logging, collecting, and monitoring to obtain understanding of integration of equipment systems and control data systems.

3. Join dispatcher and monitoring system data display for instruction simulation for dispatching rules. Look for 10 per cent improvement in production.

4. Look to computer simulation for 15 per cent more improvement.

5. Secure through complete control of business a decisive competitive edge over manual systems.

THE AUTHORS

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INTERINDUSTRY CO-OPERATION PRODUCES

HIGH-DENSITY PACKAGING SYSTEM

Fig. 1—Prototype machine developed by Mead Corp. forms containers from a single, die-cut and scored corrugated blank. When set up, the containers have three plies on the bottom and two on each side. Development led to the building of a production unit that automatically sets up containers, fills them with 50-pound loads of nails in close-packed configuration, and closes the containers.

By **WILLIAM A. WHEELER,** Chief Engineer, New Products Div., The Mead Corp., Cincinnati, Ohio

PROGRESS in packaging is being fostered by contributions from many sources. For example, suppliers of packaging materials are constantly conducting research to improve their basic materials and to adapt these materials for the packaging of every conceivable type of product. Packaging machinery builders are actively designing and building new and improved equipment that will form, fill, seal, transport, mark, count, and stack packages more rapidly and automatically than ever before. And users are searching relentlessly for better materials, forms, and methods for packaging their existing and new products.

Occasionally, however, progress becomes slowed because one or more of the principals is unable or unwilling to perform his traditional function. When this occurs, it often behooves one member of the triad to assist another or even to take over all or part of the missing function.

As a case in point, The Mead Corp., makers of paper, paperboard, and related products, recently established a New Products division. One of the

functions of this group is to conceive, design, develop, and build special machines to perform a variety of tasks in the packaging of both industrial and consumer products.

Mead entered the equipment building field primarily to enhance the market for its paperboard and related products by developing machines that solve packaging problems for customers. However, this activity might have been unnecessary if the machine building industry, and the packaging machine industry in particular, had found it economically feasible to serve all the company's equipment needs.

An example will illustrate the type of packaging problem that has been solved with the assistance of the material supplier's machinery development group. Recently, a nail making company sought to reduce manufacturing costs for its products. The problem was a pressing one since foreign competition had taken away some 40 per cent of the domestic nail market.

Inefficient packaging methods and poorly designed 100-pound capacity containers were found to be sources of high production costs. The packaging method involved filling the paperboard containers from a hopper and placing the containers on a vibrator to settle the contents. The settling operation took up to 13 minutes to perform and was unpleasantly noisy. In addition, nails often worked their way between the corrugations and the linerboards of the containers, puncturing one or both elements.

The containers used were two, three, and four-piece units that were costly to assemble. Frequently, because the nails settled unevenly in the containers and because there were air spaces at their tops, the containers did not stack properly. In using the containers, consumers often found that the easiest way to get nails was to cut the tops off the cartons. This resulted in spillage and rusting of the unused contents because there was no way to close the cartons once they had been opened in this manner.

As a first step, Mead redesigned the container so that it could be fabricated from a single, die-cut and scored corrugated blank. A 50-pound capacity container was decided upon for easier handling. The new container provides a pouring spout when open, and it can be closed and sealed after each use. Its strength exceeds the requirements imposed by the industry. Of equal importance, the container is compatible with an electromagnetic loading device that had been developed by Dake Corp.

In operation of the loader, a batch of nails to be packaged is fed between two powerful electromagnets by a vibratory feeder. As the nails fall between the magnets, they are automatically aligned longitudinally so that the batch is held suspended with the nails horizontal and parallel. When the current to the electromagnets is interrupted, the batch of nails falls as a unit into a carton below.

A missing link in the process, however, was the lack of a machine that could automatically set up the new containers. Accordingly, the New Products group at Mead built a prototype machine to do the job. The unit, *Fig.* 1, led the way to the subsequent development, jointly with Dake Corp., of a semi-automatic machine that sets up, fills, and closes five cartons per minute from blanks. A fully automatic machine, now in production, handles 10 cartons per minute. A typical nail packaging line using the automatic equipment is diagrammed in *Fig.* 2.

The reason that Mead was able to develop its portion of the nail packaging system economically is that it did the job for the entire nail industry and not for one company. This spread the development cost over a number of installations. When further efforts succeed in adapting the system for the high-density packaging of other elongated or pointed ferrous products, the unit development cost will be reduced further.

Mead also points out that its New Products group can often develop single units of specialized packaging equipment where other sources cannot justify the necessary expenditures. For example, the market may be too small for a machinery builder to recover his costs, and an individual user may have difficulty in financing a one-unit project. Mead can then step in because of the prospect of revenue from the sale of packaging materials as well as equipment.

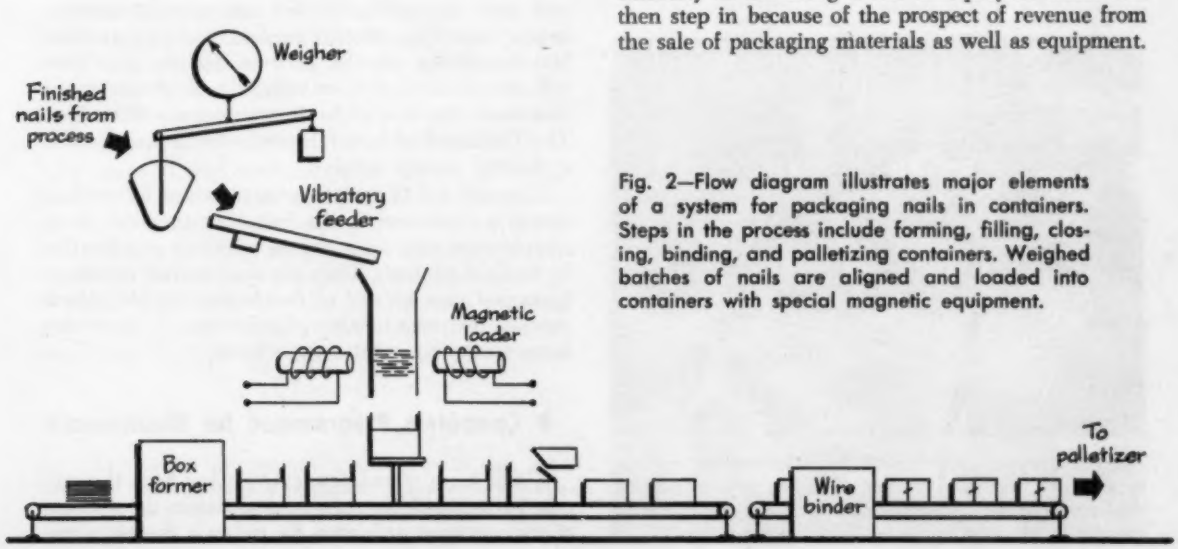

Fig. 2—Flow diagram illustrates major elements of a system for packaging nails in containers. Steps in the process include forming, filling, closing, binding, and palletizing containers. Weighed batches of nails are aligned and loaded into containers with special magnetic equipment.

COMPUTER IMPACT ON PLANT MAINTENANCE

By PETER W. SHERWOOD
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Growth of computer usage influences plant maintenance needs and the performance of maintenance duties. Especially in the area of scheduling and controlling plant maintenance, increased impact of computers is foreseen. Application of the critical path planning technique to complex maintenance jobs is seen as one of the areas of increased computer use.

DURING the 1960's extensive adoption of digital computer techniques is expected to reduce costs and improve performance and scheduling of plant maintenance. Two main factors are responsible for this development: 1. Free time is widely available on computers which were initially installed for purposes of general cost acounting, processing of sales orders, and payroll uses. 2. Complexity of the maintenance function is growing, especially in very large plants or companies.

Initial steps toward use of computers in the maintenance function have been principally in inventory control. The large memories and data-processing capabilities of modern computers permit economic daily determination of the inventory status for each piece of equipment. The optimum re-order point may be determined promptly. This results in substantial decrease in outages. It also permits a decrease in the safe minimum inventory level and therefore in the capital which must be tied up for warehousing purposes.

. . . The computer approach substitutes facts for opinion in planning the maintenance program, and it enables the maintenance group to control plant performance instead of itself being controlled by plant failure . . . .

Effect of Production-Line Computers

During the 1950's, computers began to be adapted for controlling production lines. This development, which is still making rapid strides, was primarily intended to improve production performance and labor costs. However, it also had an immediate effect on maintenance.

On the negative side, the installation of such computers, together with sensing instruments and servomechanisms, has increased the amount of required instrument maintenance. The resulting increase in costs offsets, in part, the labor savings on the production line.

However, even more important is the positive impact made by production-line computers on maintenance costs. This effect is twofold. First, production-line computers can be programmed so that they will detect developing trouble, signal an alarm, or shut down the line while the troubles are still minor. The likelihood of major breakdowns or emergencies is thereby greatly reduced.

A second aid to maintenance provided by production-line computers is the fact that they can keep complete records, in a degree which is not feasible by manual methods. They can thus provide a second-by-second case history of developing trouble, which permits the maintenance department to determine more accurately what went wrong.

Computers Programmed for Maintenance

A still more recent development has been the specific adoption of computer techniques to the solution of maintenance problems. By giving a complete rec-

ord of all equipment in the plant, this approach permits improvement in the cost, cost control, and scheduling of the entire maintenance program. The computer approach substitutes facts for opinion in planning the maintenance program, and it enables the maintenance group to control plant performance instead of itself being controlled by plant failure.

Computers require input information, and for maintenance programs the following data must be provided regularly: 1. Service or repairs requested (by equipment item). 2. Record of repairs (by item and by cost components). 3. Performance record of each piece of equipment. 4. Delays and downtimes due to individual equipment items.

Analysis of maintenance on each item is then possible by frequency, severity of difficulty, and trend of performance. A comparison of different types or makes of equipment performing the same function can also be effected. Information of this type may be adapted to provide guidance to routine maintenance.

Complete performance and maintenance records can be provided on each piece of equipment. A declining performance level may be a warning sign that maintenance is required or that the equipment itself should be replaced. Similarly, warning can be given by the computer if its analysis shows that a given piece of equipment is subject to excessive emergency maintenance and that a replacement should be of different design.

Detailed analysis of past performance records is possible for each piece of equipment by the use of computers. Based on statistical evaluation, a forecast can be made of the stage in the equipment's operating life (number of on-stream hours) at which normal failure may be expected to occur. This ability to forecast normal failure permits timely replacement of equipment and thus minimizes interruptions of production. Furthermore, analysis of the statistical failure curve permits determination of whether routine maintenance is provided frequently enough or whether it is provided too often for most economical operation.

Computers can also provide a rational basis for planning a preventive maintenance schedule. Once the plan is established, the computer will keep track of the schedule's execution and remind the department of planned routine maintenance and of needed calibration for the various plant components.

In terms of cost savings which can be achieved, the benefits of computer application to maintenance are in three major categories: 1. A computer offers better control of maintenance labor scheduling with a notable reduction in overtime requirements. 2. Weak links in the production line where a redesign may lead to savings in maintenance cost can be pinpointed. 3. A more accurate item-by-item record of maintenance cost can be kept to permit better maintenance scheduling, cost budgeting, and planning for purchase of new equipment.

. . . Key output information is the over-all cost performance under various feasible maintenance work programs and the optimum schedule under which the lowest over-all cost can be achieved . . . .

▷ Planning Major Maintenance

To date, the principal emphasis in computer application to the maintenance program has been concerned with recordkeeping, retrieval, and analysis of a fairly routine character. More recently, the scope of computers has been expanded to facilitate the over-all maintenance planning function. This approach is proving particularly fruitful in scheduling complex maintenance jobs, such as turn-arounds in the process industries, where it can achieve remarkable savings, both in cost and in required time.

In this area, too, the advantage of computers rests in their ability to account for many difficult variables in a very short time. It is thus possible to investigate a great many different feasible schedules, in order to select the case which is the optimum from the over-all point of view. Since a major maintenance job generally makes it necessary to shut down some production equipment, it is necessary to consider the sum of expenses arising due to loss of production and due to cost of maintenance under various programs.

From the point of view of production costs alone, the shortest possible maintenance time is desired. However, this means scheduling each job component on a crash basis. Premium rates must therefore be paid for equipment and for overtime labor, and maintenance costs for this case are at a maximum.

At the opposite end of the scale, the maintenance job may be scheduled to allow standard time (both in equipment delivery and work performance) at each stage of the program. This is the case for which maintenance costs are at a minimum. However, downtime is longest and production outage costs are highest.

The optimum maintenance schedule will generally be found to be some intermediate case in which some of the job components are carried out under a crash program, while standard time is allowed for the remainder. Any mathematically sound analysis of the maintenance schedule may serve as the basis for the computer program designed to select the optimum approach. In a recent paper,* R. C. Steinfeld of E. I. duPont de Nemours and Co. showed, for example, how the "critical path" method may serve for both manual and computer scheduling of major maintenance jobs.

This method subdivides the entire maintenance job into its individual components and then asks three key questions of each: Which job components must precede? For instance, an overhead pipe cannot be installed until after the scaffolding has been set up. Which job components can be carried out simultaneously? Which job components follow? It will be found that a series of job components, from the beginning to the end of the project, must be carried out in succession, and these items make up the critical job sequence.

Other components may be carried on simultaneously with the critical jobs. These do not affect the over-all timing. It must be noted, however, that a crash program in some of the main chain jobs can cause previously non-critical jobs to become critical so that a different sequence of jobs may make up the main chain under an alternative schedule.

All the various possibilities in different job components must be taken into account with regard to their effect on timing (outage cost) and maintenance expense. Other variables are imposed from the outside—effect of weather, time of delivery for equipment items, existence of delivery contracts, etc. Taking account of these different components, various paths of job sequence can be designed for performance of the work and resultant over-all costs.

For simple programs, consisting of only a few variables, solution by manual calculation is feasible. For complex jobs, however, an analytical basis for optimum scheduling can be accomplished with practical results only by use of a computer. Input information to the computer includes all of the variables in job components and sequencing which have just been outlined. Key output information is the over-all cost performance under various feasible maintenance work programs and the optimum schedule under which the lowest over-all cost can be achieved.

*R. C. Steinfeld, *An Introduction to Critical Path Planning and Scheduling*, presented at a meeting of Western Petroleum Refiners Association, Houston, May, 1960.

——electrostatic system sprays magnesium parts

ELECTROSTATIC paint spraying offers many advantages to industrial users. Of prime importance is the elimination of overspray waste, reducing the amount of paint and solvents required and consequently the costs of raw materials. However, when yearly usage of paint is small, other considerations become important. These considerations involve the appearance of the painted product, the durability of the finish, and the ability of automatic equipment to produce a flawless finish without requiring touch-up.

Dictaphone Corp. uses about 1000 gallons of paint per year, and paint economy alone could not justify the installation of electrostatic paint spraying equipment. However, uniformity of appearance and high quality of paint finish were important to the appearance of their dictation machines. When the corporation decided to install automatic paint spraying equipment, they elected to try electrostatic painting equipment provided by the Ashdee Div., Atlee Corp.

The initial installation consisted of a finish spray booth equipped with two gun stands, each stand having three nozzles. The workpieces, consisting mostly of magnesium castings, are hung on Christmas tree type holders which are rotated as they pass through the booth. Conveyor speed of the holders is approximately 3 feet per minute. The system is adjusted to apply a 1.25-mil dry film thickness with a uniformity that has set a new standard of appearance.

The first finish coat is a relatively heavy covering, followed by a second coat applied with very low paint pressure and slightly higher air pressure. This technique, especially developed for metallic paint, produces the desired effect of emphasizing the metallic sheen by keeping the metal particles close to the surface.

The success and trouble-free operation of the initial installation prompted the company to install a second electrostatic painting system for applying a prime coating. In this system, the gun stands and nozzles are grounded, and a tubular U-shaped high voltage electrode is suspended between the nozzles and the conveyed workpieces. Primer is fed from a pressurized vessel, and the workpieces are rotated on hangers as they are conveyed through the booth.

Interior view of the prime spray booth shows the relation of the spray nozzles to the workpieces. Spray from the grounded guns is directed through the U-shaped high voltage electrode where it is electrostatically charged and subsequently attracted to the grounded workpiece on the conveyor. To assure full coverage, the workpiece holders are rotated as they pass the spray position.

TRANSFER LINE FOR APPLIANCE PARTS

A NATURAL consequence of the development of unitized or modular machine tool elements has been the extension of transfer machining into new areas. A case in point is a transfer machine built by the Buhr Machine Tool Co. for the Hotpoint Div., General Electric Co. to process parts for automatic washer transmissions.

The general arrangement of the transfer line, *Fig.* 1, is that of a closed loop. In operation, two parts to be machined (one of two styles of transmission cases and a common cover plate) are mounted on special pallet fixtures which carry the pieces through the 12-station transfer machine, a wash and blow-off booth, and a wire brush deburring station. Included in the 12-stations of the machine proper are seven work stations, a power wrench station, pallet entry and exit stations, and provisions for two future work stations.

At each of the seven work stations operations are performed simultaneously on both sides of the two parts in each fixture. Thus, while there are only seven work stations, the machine actually utilizes 14 multiple spindle machining heads. In total, 126 separate cutting and probing operations are performed on the two parts. Cycle time is 27 seconds.

On each transmission case, pinion and gear shaft holes are drilled, chamfered, semifinish bored and finish bored. Clutch skirt and face are rough and finish bored and faced respectively, along with a gasket groove from the opposite side. The oil seal is rough and finish bored. Six cover screw holes are also drilled.

On the cover plate, a clutch hub is rough and finish turned. The spinner shaft hole and three gear shaft holes are drilled, chamfered, spot faced, semifinish bored and finish bored. A filler plug hole is drilled and pipe tapped. In addition, two manufacturing holes for use in subsequent assembly operations are drilled and reamed in both the case and cover.

Improvements in quality of the parts has been obtained due primarily to the close tolerances which the transfer machine is able to hold. For example, the center hole for a pinion gear is held to within 0.0007 inch of true center location. Three gear shaft center holes are held to within 0.001 inch of true

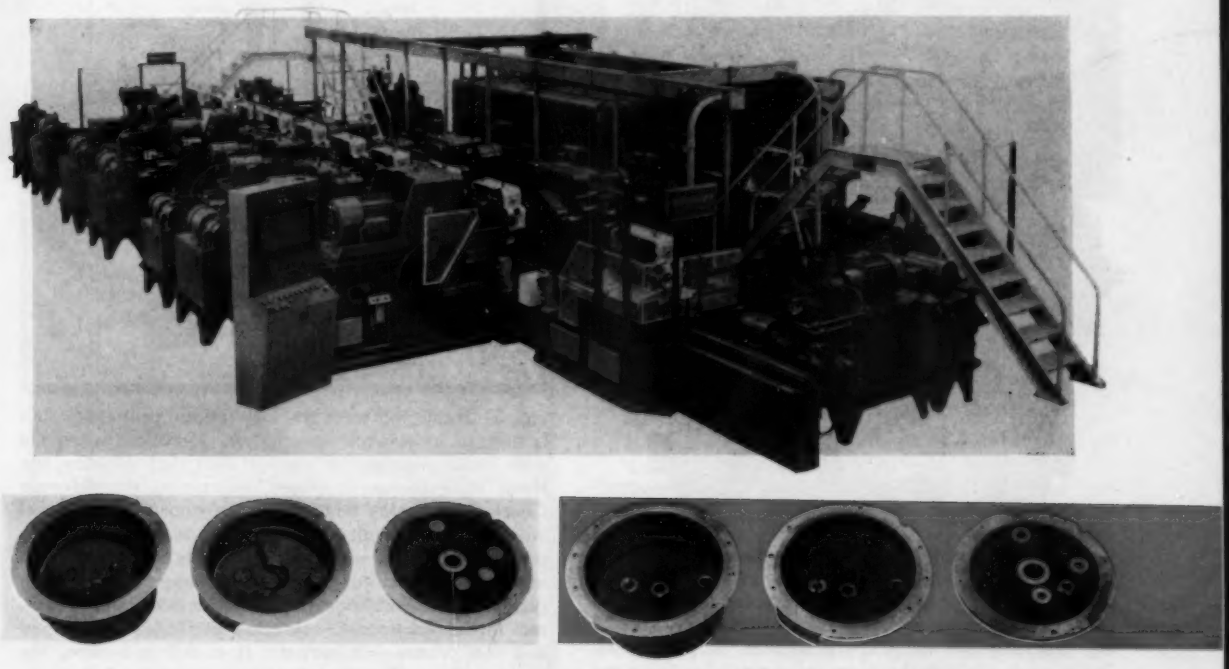

Fig. 1—Closed-loop palletized transfer machine processes parts for automatic washer transmissions. The pictures of the parts indicate before and after machining conditions. The two parts on the left of each group are the two styles of transmission cases handled. The third part is the common cover plate. Only tooling changes are required to accommodate the different transmission cases.

center. A machine capability performance check (involving 120 consecutive sets of parts) indicated 0.00045 inch repeatability on bore centers.

Among the noteworthy features of the machine are the pallet fixtures, *Fig.* 2; the technique of checking for broken tools, *Fig.* 3; auxiliary support clamps that back up the pallet fixtures during heavy plunge machining operations, *Fig.* 4; and the operation of the clamping station, *Fig.* 5.

The control console for the line is adjacent to the load and unload station. Neon indicator lights on the console show when each machine tool head is ready to cycle and when each has completed its cycle. Each hole is probed by an automatic low-voltage detection system after every cycle. If there is an obstruction of any kind, a red light signals that situation at the station. Failure is also reflected at the console. A lubrication failure at any point in the machine automatically shuts down the entire line.

To maintain a continuous check on the condition of all tools, two special control boards have been developed. The boards contain a series of electric counters, one for each tool, which record the number of cycles for each tool. Maximum tool life, predetermined by tests, is indicated by a red pointer. Whenever a tool reaches its use limitation, it is replaced. Resharpened tools are kept at the control board opposite their respective counters. Three sets of tools are provided for each spindle: One in use, one on the board, and one in the tool room for resharpening and resetting.

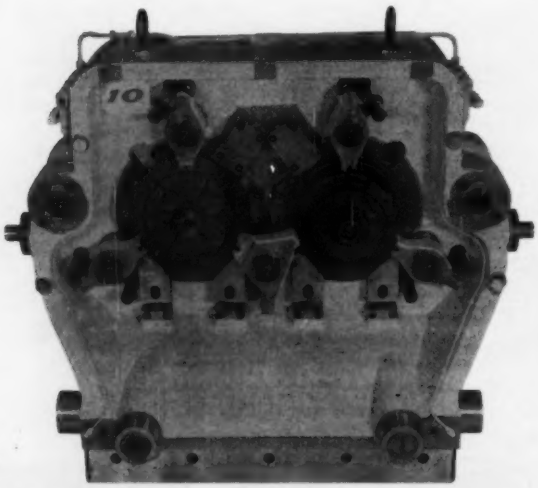

Fig. 2—Transfer line has been provided with 15 pallet fixtures. All are interchangeable. As shown, each pallet can hold one of the transmission cases and a cover. Parts, previously machined to provide qualifying surfaces, are manually positioned in the fixture. The operator orients the parts by means of a vee-notch in the periphery of each part. The reverse side of the fixture and the means by which the parts are clamped are discussed in *Fig.* 5. Pallets do not slide in moving between stations but are conveyed on the rollers located near the bottom of each pallet.

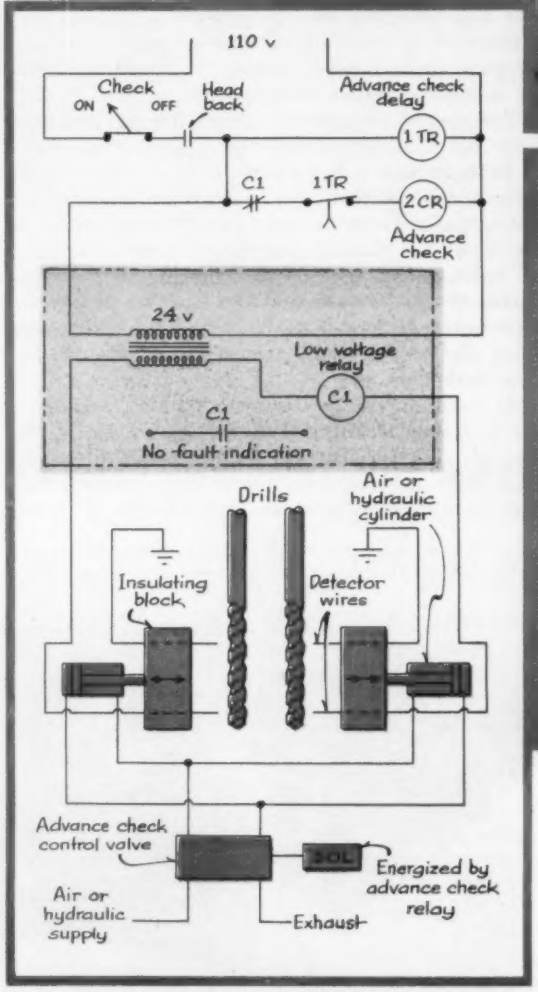

Fig. 3—Sketch indicates the low voltage drill check that is utilized at several stations. In operation, when the drill head reaches its normal retracted position the *Head Back* contact is closed, energizing the *Advance Check Delay* relay timer. The *Advance Check* control valve is also energized and the cylinders advance the probe or detector wires. If both drills are present and intact, the detector wires will complete a circuit energizing the *Low Voltage* relay. A normally closed contact in the *Advance Check* relay circuit is then opened and the probes will retract. If a drill is broken, the probe wires will not complete a circuit and the *Low Voltage* relay will not be energized. Remaining in an open mode, a normally open contact in the *Low Voltage* relay will signify a fault. In the event of a broken drill, the probes will remain advanced until the *Advance Check Delay* timer times out.

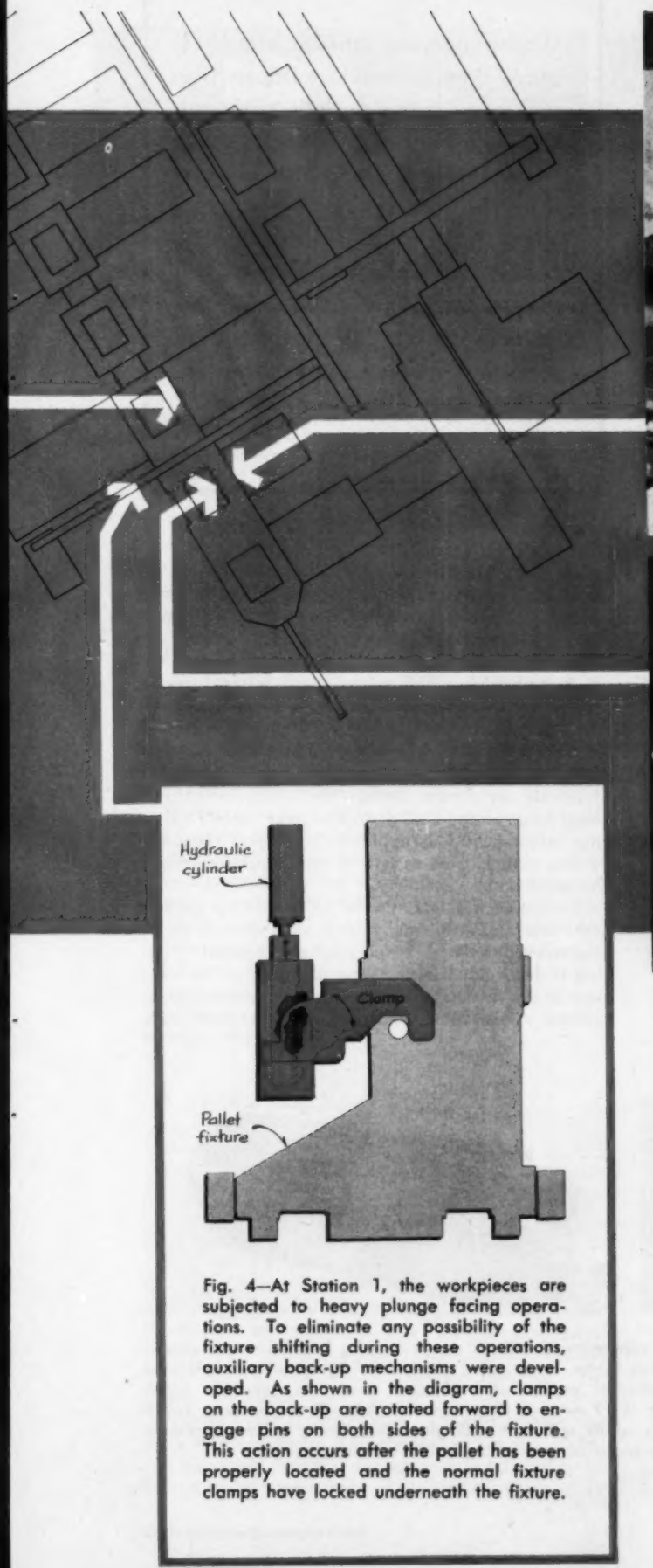

Fig. 4—At Station 1, the workpieces are subjected to heavy plunge facing operations. To eliminate any possibility of the fixture shifting during these operations, auxiliary back-up mechanisms were developed. As shown in the diagram, clamps on the back-up are rotated forward to engage pins on both sides of the fixture. This action occurs after the pallet has been properly located and the normal fixture clamps have locked underneath the fixture.

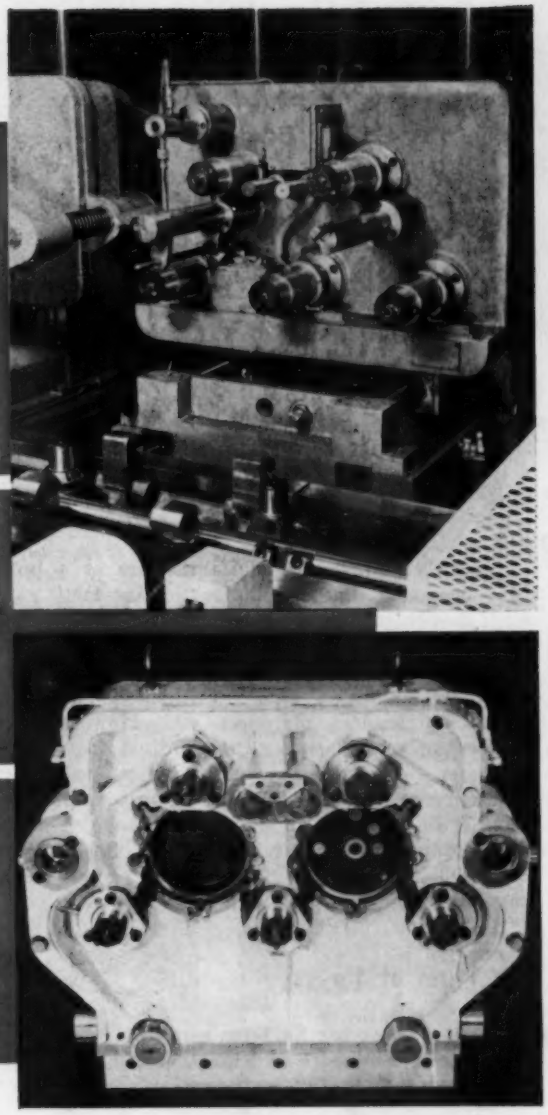

Fig. 5—The pictures show the automatic power wrench or clamp station (top) and the face of the fixture presented to the station (bottom). Following the positioning of the two parts in the fixture, the operator presses two push-buttons. Five air driven wrenches then advance to mate with clamping mechanisms on the fixture. The clamps are automatically tightened, securing the parts in the fixture. Simultaneously, a lubricating gun (upper left on clamp station photograph) moves in and shoots a charge of light grease into a fitting on the fixture. Grease is carried to all bearing surfaces on the pallet fixtures through manifold systems contained on each fixture. Also shown in the top picture are the two 2-inch diameter shot pins which mate with holes in the bottom of the pallet fixture to position the pallet. In the same area can be seen four clamps that are hydraulically actuated to grip the pallet from underneath to hold it against the center rail.

SYSTEMS TO CONTROL TIME CYCLES

Where process specifications require that certain conditions prevail for specified periods, time controls are indicated. Systems range from simple *Start-Stop* of one element to complex interlocking of many functions. Timers may be applied in circuits to accomplish programming of required sequences as well as to limit time periods. Practical applications include a wide range of processes.

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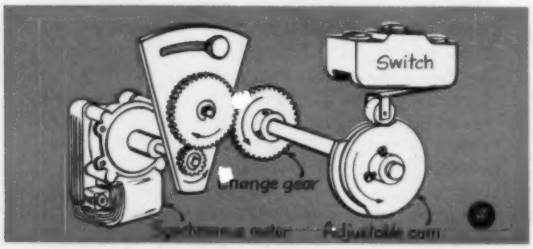
MANY processes require the use of a programmed time system for the automatic operation of the numerous components that perform the process. Some systems have been highly standardized and developed for mass production. They are found on automatic domestic washers, stoves, refrigerators, defrosters, etc. However, industrial processes are not standardized making it necessary to construct systems for each particular requirement. Fortunately, timer manufacturers now have a wide selection of standard units which serve as building blocks for such systems. Basic timer types will be described in this article together with suggestions for their use in automatic systems.

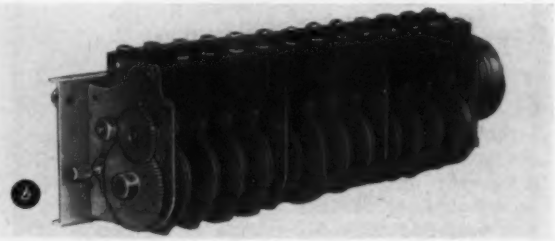
Types of Timers

A timer, as we use the term here, is a control device with one or more switches that can turn electrical loads *On* or *Off* according to a timed program. A timing mechanism most commonly used in control systems is the hysteresis-type synchronous motor. These components have been developed to a high degree of reliability and are low in cost. They also have a number of advantages over other timing methods. The motor speed is synchronous with the power line frequency which for all practical purposes is without error. This characteristic makes it possible to calibrate timer dials so that they read directly in time. The units will repeat intervals accurately, within the other mechanical limitations of the unit, year after year. Also, a timing motor is just as applicable to a unit requiring a few seconds time as it is to one requiring several hundred hours.

Electronic timing is useful for short time periods that are repeated rapidly such as resistance welding where fractional second timing is required. Timing is determined by the time required for the voltage across a condenser to reach a predetermined value. This voltage triggers an electronic tube

This article is based on a paper presented at the "Fifth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and the Manufacturing Engineering Council, April 1961.





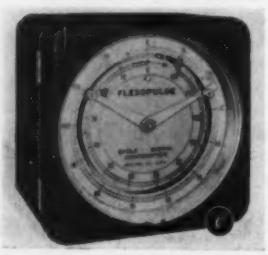


Fig. 1—Operation of a repeat cycle timer is shown in *(a)*. Adjustable split cam is driven by a synchronous motor at a speed determined by gearing. Split cam allows adjustment of On-Off portion of each cam revolution. Multiple switch timers *(b)* may have up to 12 switches in standard frames. Timing at each switch is adjustable by means of its split cam. Single switch timers *(c)* are available with dial adjustment in place of gear change and cam adjustment.

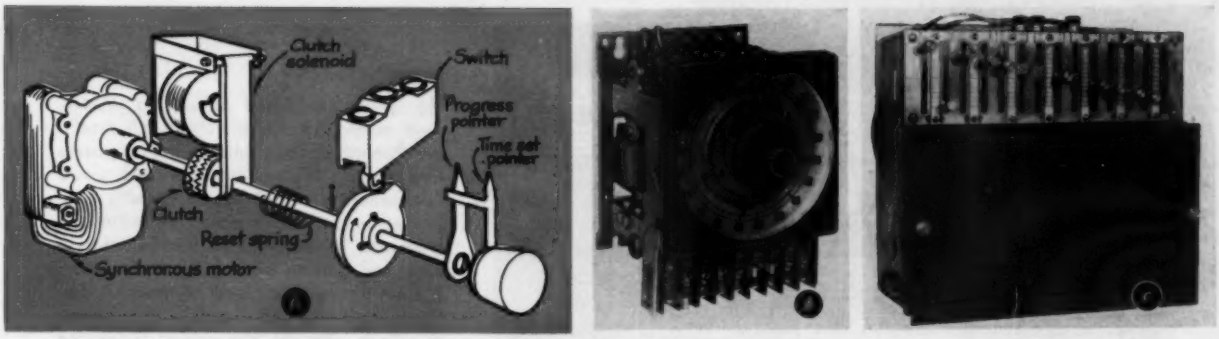


Fig. 2—Reset timer *(a)* has a solenoid operated clutch. Timing starts from zero when the clutch solenoid is actuated by external signal device. At the end of timing cycle, the clutch is disengaged, and the reset spring returns the shaft and pointer to zero. Dial type reset timer *(b)* has a 20 turn dial that allows the timer to be set to an accuracy of 0.1 per cent of full scale. Sequence reset timer *(c)* has adjustable sliding bars for setting the *On-Off* time of each of seven switch circuits.

which in turn operates a relay. The time period is controlled by an adjustable potentiometer which regulates the flow of charging current to the condenser. A practical limit of time period is 10 seconds although the time range can be extended to two minutes with decreased accuracy. Voltage fluctuations and temperature variations likewise affect timing although some timers have compensating means to limit such timing variations to 3 per cent for average service conditions.

Time delay relays using a pneumatic timing head are widely used for short time delays. In these units, air is drawn through an adjustable orifice into a chamber having a diaphragm. As more air enters the chamber, the diaphragm expands and actuates a switch. Timing is confined to short intervals since the orifice must be proportionally smaller as the time interval becomes longer and its size becomes too critical. Limiting the use of pneumatic timers to intervals less than one minute is recommended.

▶ Synchronous Motor Timers

Process control timers using synchronous motors are of three different types, namely, manual set timers, repeat cycle timers, and reset timers. The manual set timer is the simplest type and has a knob and dial. The knob is manually turned to a selected time on the dial which action closes a switch. The synchronous timing motor drives the knob back to zero and opens the switch. Since the timer must be manually set for each operation, its use is restricted to simple systems, and it cannot be used where the system operation must be completely automatic.

Repeat cycle timers, *Fig.* 1, are used where the controlled equipment is to operate completely according to a timed program. For example, a pump may be life tested by a test cycle of 30 minutes *On* and 10 minutes *Off*. A feed pump may feed chemicals for 30 seconds every 10 minutes. In another case, a conveyor moving carriers through plating tanks may operate 5 seconds forward and 3 seconds reverse. This reciprocation provides a dual function of agitating the liquid to ensure a more uniform plating process and controlling the plating time. The ratio of the forward time to the reverse time determines how long a piece stays in a tank.

A repeat cycle timer may be visualized as a device in which one or more switches are actuated by a continually rotating cam. The speed of the cam determines the total cycle time, and each switch closes and opens during each cam revolu-

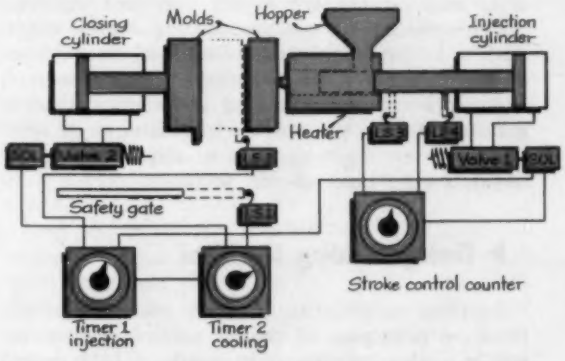


Fig. 3—Use of timers to control the cycle of an injection molding press is shown. When operator closes safety gate, limit switch *LS1* closes and energizes Timer 2 which times over-all press cycle. Timer 2 energizes solenoid of Valve 2, causing spool to shift and admit oil to blind end of closing cylinder. Piston causes mold to close, actuating limit switch *LS2* which energizes Timer 1. This timer energizes solenoid of Valve 1, causing spool to shift and admit oil to blind end of injection cylinder. Piston moves ram forward and injects plastic into mold. When Timer 1 times out, solenoid of Valve 1 is de-energized, spool of Valve 1 is spring returned, oil is admitted to rod end of injection cylinder, and ram retracts. When Timer 2 times out, solenoid of Valve 2 is de-energized, allowing mold to open. During the time the ram cylinder is under control of Timer 1, the ram can be reciprocated two or more times to compact plastic material in the heating cylinder by means of the stroke control counter and limit switches *LS3* and *LS4*.

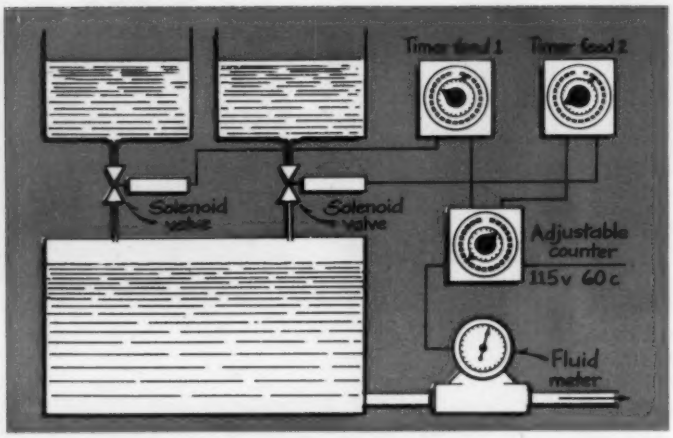


Fig. 4—In this liquid measuring system, fluid meter initiates a pulse each time a predetermined amount of liquid passes through it. Pulses are counted on a reset counter whose dial is directly calibrated in gallons or other measuring increments. When selected number of gallons has passed through meter, timers 1 and 2 are energized to admit additional fluids to main tank. By varying the timer intervals, the added fluids can be properly proportioned to meet the specifications of the main tank mixture.

tion according to cam settings. Because of the unlimited number of combinations possible with different cycles and different numbers of switches, repeat cycle timers usually have to be assembled from standard parts in accordance with a purchaser's specification.

Reset timers, *Fig.* 2, start timing from their zero position as soon as they are energized. Upon completion of a time cycle, they automatically reset to the zero position. They are also called delay relays, single cycle timers, or interval timers. Reset timers are universally used because their ability to start from zero permits introducing nontimed variables into a system. An operator loading a press might push a button upon completion of loading to start a timer controlling the press cycle. In another case, a pressure switch might close and start a timer to maintain a given pressure for a predetermined time. Whenever an input signal is to start a timing interval, a reset timer should be used.

▶ Timing Molding Machines

Injection molding machines for plastic materials illustrate principles of timing controls which are widely used for process control today. In a typical plastic molding process, plastic pellets are fed from a hopper into the rear end of a heating cylinder. With successive strokes of an injection ram, the material is compacted and plasticized. The mold is then closed hydraulically, and the hydraulically operated injection ram forces the plasticized material into the mold.

A simplified version of an injection molding press is illustrated in *Fig.* 3. The cycle is started by the operator each time he closes the safety gate. While the machine operates on a repetitive cycle, note that only two parts of the cycle are controlled by timers. The other parts are performed sequentially by limit switches.

Another function is performed within the operating cycle. This function is compacting plastic material in the heating cylinder and requires 2, 3, 4, or 5 strokes of the injection ram. The number of strokes is selected based upon the job being molded and is adjustable by means of a reset counter. This counter is essentially a reset timer with the timing motor replaced with a solenoid and ratchet. The unit operates from pulses to its ratchet mechanism instead of by time. Two limit switches, one at each end of the injection stroke are used as a means of terminating the stroke in each direction. The counter is connected to one of the limit switches to accumulate the number of counts and open the circuit to the solenoid of the valve controlling the movement of the injection ram.

▶ Liquid Measuring

The use of timing to measure a predetermined amount of liquid material is self-evident where there is a constant pressure to ensure an even flow or when a pump may be operated for a specified time. Applications where flow is irregular may be solved by using a fluid meter which initiates an electric pulse as a predetermined amount of liquid passes

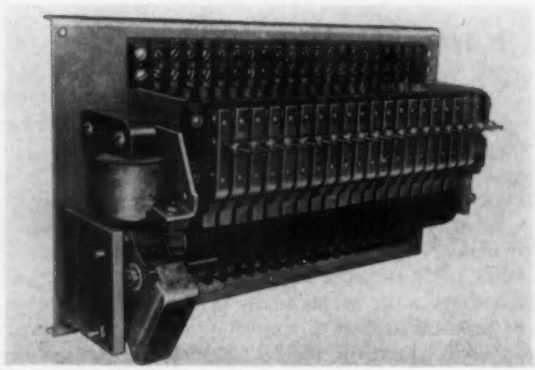
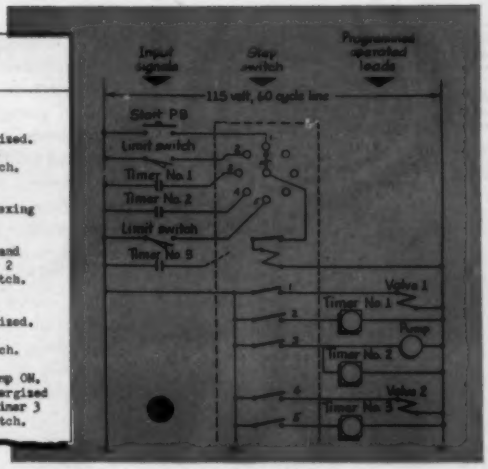


Fig. 5—Step switch with 20 contacts provides a programmed sequence of switch operation. Switch cams are advanced step-by-step by pulses from external controls. Step switch is useful in combining the operation of different components into an interlocked system.

Step Switch Position	Input Signal To Advance Step Switch	Closing of N.O. Load Switches						System Operation
		1	2	3	4	5	6	
1	Pushbutton							Index step switch.
2	Limit Switch 1	X						Solenoid of Valve 1 is energized. Piston of valve closes Limit Switch 1, indexing step switch.
3	Timer 1	X	X					Valve 1 is open. Timer 1 is energized and times out, indexing step switch.
4	Timer 2	X		X				Valve 1 is open. Pump motor and Timer 2 are energized. Timer 2 times out, indexing step switch.
5	Limit Switch 2	X		X	X			Valve 1 is open and pump ON. Solenoid of Valve 2 is energized. Piston of valve closes Limit Switch 2, indexing step switch.
6	Timer 3			X	X	X		Valves 1 & 2 are open and pump ON. Solenoid of Valve 1 is de-energized and Timer 3 is energized. Timer 3 times out, indexing step switch.

(a)



(b)

Fig. 6—Listing the output circuit functions in chart form *(a)* is the first step in designing a step switch control system. The complete operation cycle is divided into steps with a different step for each interval that the load switches are closed. An electrical circuit diagram *(b)* can be made from this chart. The limit switches and timers in the circuit serve to feed back signals to the solenoid operated ratchet as each function has been completed.

through it, *Fig.* 4. These pulses are counted on a reset counter. The counter has a dial which can be calibrated directly in gallons and can be set for a selected number. In cases where the fluid is to be proportioned with other fluids, the counter can start a timer to control each added material.

The control elements in such systems are the timers and counters. These elements are completely electrically controlled so that the system can be made fully automatic. Also, each part can be set by its own adjustable dial which provides a simple method to meter a selected volume automatically.

▶ Programmed Sequence Control

Timing systems usually require a control panel with several relays as well as the timers. A panel for an injection molding press may use 1 to 6 additional relays to provide electrical interlocks and holding circuits to establish the necessary sequencing. As systems become more complex, additional relays are required. In many cases, the use of a multicontact step switch will simplify a control circuit, making the circuit easy to design and maintain.

A step switch, *Fig.* 5, has a series of switches, each controlled by a separate cam. The cams are mounted on a shaft which is advanced step-by-step by a solenoid operated ratchet. Thus, one or more switches may be closed in any one position, depending upon the contour of the cams.

The design of a control system using a step switch is simple. The reqirements of the system are first listed as shown in *Fig.* 6*a*. Each line represents a step in the process. The output load function indicates which components in the control system are energized. The input signal column lists what input device operates to advance the step switch to the next position. Any number of input signals up to 16 can be used.

The chart can be easily translated into a circuit diagram as shown in *Fig.* 6*b*. One input signal device is connected to each terminal of the step switch, and a load is connected to each load switch. The step switch cams can be set to provide the required *On-Off* operation for each load switch as the step switch is indexed step-by-step. In addition to its simplicity, the step switch provides a definite interlock as the input signals must occur in a specific sequence or the system will not function. Likewise, if one of the input devices fails, the process will stop. An additional safeguard is that the load circuits are controlled by the cams which are mechanically locked upon a shaft, and the load circuits must always be closed and opened in a given preselected order.

Step switch timing systems find application in various processes. An example is an ion-exchange water treatment plant, *Fig.* 7. Upon exhaustion of the exchange units, a completely reliable and accurate sequencing of valves, pumps, etc., is required for the regeneration of the unit. Timers are used for setting the backwash, regenerant injection, displacement and rinse intervals. Note that some of the input signals are initiated by devices which operate from valve position, tank level, and conductivity. Each condition, whether it be time or other condition, must be satisfied before the programming can continue.

The step switch concept is also applicable to timed functions that occur in sequence by using a timer to periodically step the switch ahead. Should you wish to control a number of loads in equally timed intervals, a repeat cycle timer can be used to advance the switch periodically. This concept can be used in a dust collector system in which a number of compartments are to be automatically cleaned sequentially. In other cases a series of machines can be started sequentially at equally spaced intervals. Sugar mills use this system where a bat-

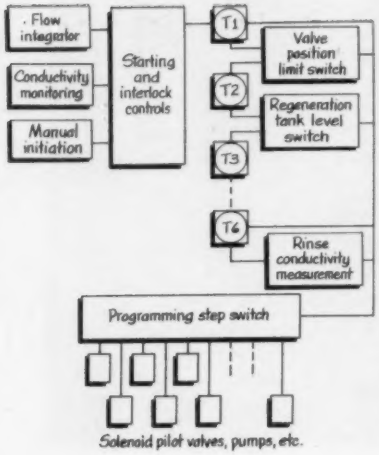


Fig. 7—Timing system for a water treatment plant uses a step switch to ensure that all valves, pumps, and other components in the process are operated in proper sequence. The process may be started by a flow integrator, by a conductivity monitoring device, or manually. Once the process is started, it is completed automatically under control of the step switch. Some steps are timed intervals while others are initiated by position of valves, tank levels, fluid conductivity, and similar control devices.

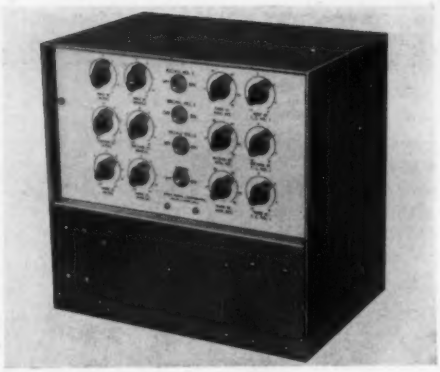


Fig. 8—Traffic signal controllers use a step switch to operate the signal lights in sequence. Electronic timing is used and potentiometers can be adjusted to set the timing for each signal combination

tery of machines are started, and the sugar is discharged in batches. By using the step switch control to start each cycle, the batches are discharged at equally spaced intervals. This provides an even load distribution to the discharge conveyor and subsequent handling equipment.

The step switch concept is also used in many of the timing systems for traffic signals. The systems operate strictly on a timed basis and employ a synchronous motor timer which sends pulses to advance the step switch, changing the lights from one signal to another. There are other systems which operate partly on a timed basis and partly from input signals received from a detector indicating the approach of a vehicle. These are called traffic actuated systems and are designed so each car receives the green light as quickly as possible. Timing is provided by an electronic timer, *Fig.* 8. Each position of a step switch connects a different timing potentiometer into the light circuit. Each potentiometer may be set for a different time interval. However, only one electronic timer is required since its timing condenser is connected to a different timing potentiometer in each position of the step switch. This provides a relatively inexpensive way to obtain a large number of adjustable timing intervals for a control system.

▶ Simplifying Maintenance

The increasing complexity of modern processes is making it more difficult to trace trouble to a specific component which may be malfunctioning. Timer manufacturers are recognizing this problem and are offering plug-in timers so that units suspected of giving trouble can be replaced in an instant without disconnecting any wires. Often maintenance personnel are not sufficiently experienced to intelligently diagnose the trouble so this plug-in concept provides a trial and error method by which they can run down the trouble in a minimum time.

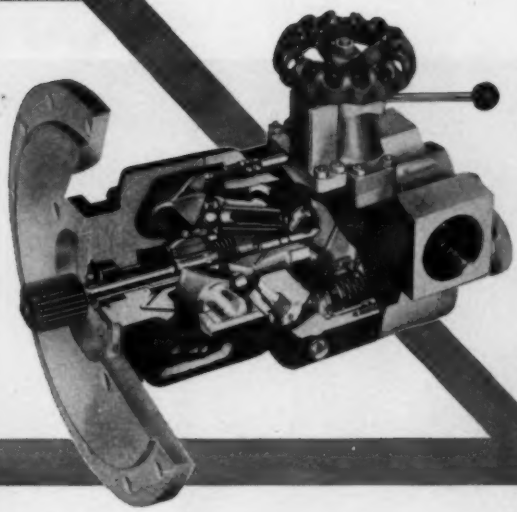
Plug-in units make it possible to have a test kit in which the unit can be inserted to check out the operation of the timer itself. It is a common occurrence to receive a timer at the factory for repairs which functions perfectly but the user was not sufficiently familiar with the unit to know how to test it. The test unit can also be built right into the control panel. A pushbutton or switch is used to start the test cycle, and pilot lights indicate the proper functioning of each contact. This test position serves as a convenient place to store a spare timer at the spot where it is used and can be transferred to the proper receptacle when needed.

New processes to increase productivity and quality are being developed daily, and many of these processes require timing systems. A few basic ideas have been presented here to suggest approaches to certain types of problems. However, the timing requirements are so varied and there are so many different types of timers offered that consultation with the manufacturer's sales engineer is recommended in the early stages of the design. Usually, helpful suggestions can be made to improve the efficiency of the system.

THE AUTHOR

VINCENT C. BLECKER graduated from the University of Iowa in 1935 with a BS degree in Electrical Engineering. Since that time he has been employed by Eagle Signal Co. in Product Design and Application Engineering. Since 1959, Mr. Blecker has been the manager of the Industrial Sales Division.

Nine piston, variable volume, pressure compensated type IA-38-9 pump, designed for use on Ground Support Equipment.



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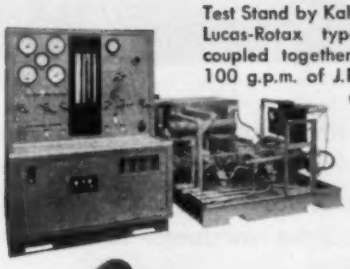

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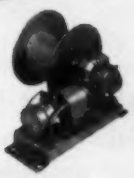

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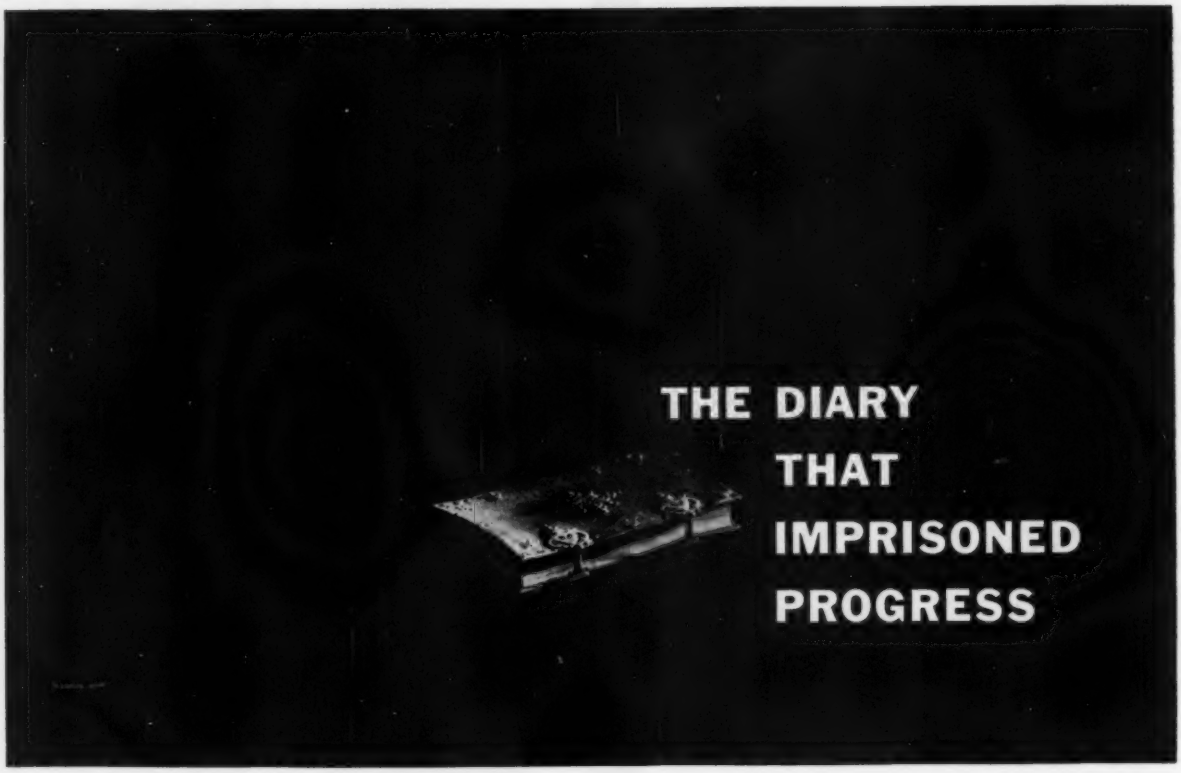

Nearly two centuries ago, Karl Gauss, "Prince of Mathematicians," kept a diary which was destined to become one of the most significant documents in the history of mathematics.

In his diary Gauss jotted down the results of elaborate calculations that had led him to fundamental discoveries in mathematics. But he never published these discoveries, and many of them remained undisclosed during his lifetime.

It wasn't until almost 50 years after Gauss's death that his diary was found and published. Much time and talent, meanwhile, had been spent in duplicating Gauss's efforts. Mathematical progress had been needlessly slowed.

In contrast, today's scientists and engineers are alert to the importance of sharing their findings through publication. In fact, the number of definitive papers published in a scientific or technological field has become a sure sign of the creative effort in that field.

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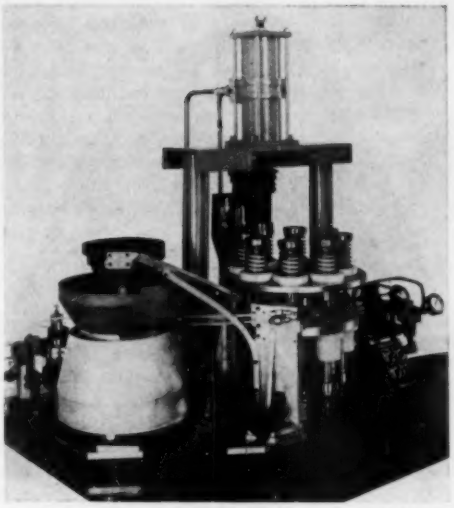
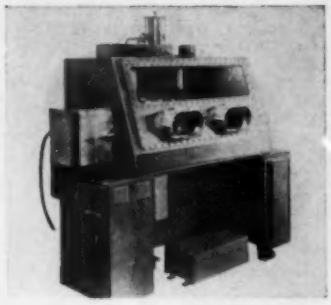
Transistor welding system before being enclosed in a nitrogen atmosphere. Full control of the system is maintained with four selector switches (right) and a foot pedal. Nylon rollers bearing on a barrel cam automatically vary the height of the lower electrodes as the table indexes. Double deck arrangement of opposing electrodes eliminates accuracy of indexing as a major factor in welding small parts.





Welding equipment, feed mechanisms, and dial table are enveloped in a nitrogen atmosphere. Operator uses openings in cabinet to load transistor headers, then starts the machine sequence with foot operated switch. The system operates continuously until operator depresses switch to stop it.

Transistor Welding System

DEVELOPED by **Thomson Electric Welder Co.**, 161 Pleasant St., Lynn, Mass., integrated and sequenced welding system loads and welds TO-5 or TO-18 transistor components and unloads an assembly at rates of speed ranging from 17 to 23 per minute. It comprises a 30 kva two-column welding machine, an eight-station indexing table, and two stacked vibratory feeding mechanisms. All steps, except loading transistor headers, are performed automatically, and all are done in a controlled atmosphere chamber.

Bench-mounted Model 700 welding machine shares control of the system with the indexing table and produces high quality projection welds between a transistor can and a header. The welding head operates in a vertical plane to engage a pad on each of eight upper electrodes. A double acting diaphragm type, overhead air cylinder motivates the head and produces 700 lb of welding pressure at 80 psig. Piston stroke is $\frac{3}{8}$ inch; cylinder bore is $3\frac{1}{2}$ inches.

Geneva index table consists of upper electrodes; the lower electrodes; nylon rollers and a barrel cam that bolts around the base of the table; and a speed reducer, electric motor, and drive train. As the table indexes each lower electrode is cammed upwards. As each electrode approaches its apogee its nylon roller bears on a spring-backed segment provided at the rear of the barrel cam. Concurrently, the electrode is imposed over a grooved contact pad. At this point the welding cycle starts.

In sequence, the welding head descends, engages, and depresses the upper electrode against the lower; the work is welded. The spring-backed segment absorbs the pressure exerted on the roller, and when freed of the force, returns the roller to its original path of travel. Leaving the welding zone, the station overrides another cam, mounted on the base of the table, that engages the lower end of a $\frac{1}{4}$-inch diameter nylon pin running through the lower electrode. The nylon pin raises to push against the welded assembly and lift it out of the die. A permanent magnet on the top end of the pin holds the assembly until a nitrogen powered ejector cycled by the air cylinder in the welding head removes it onto a chute.

A vibratory feeder with two stacked bowls and two tracks automatically supplies transistor cans to the lower electrode dies. The operator loads the stems in the upper electrode manually. Actuation of a selector switch determines which bowl is vibrated, and thus the particular size of can to be fed. Each has its own terminal point on the table.

Speed of the indexing table is adjusted with a hand crank extending from the rear of the machine cabinet. Initiation of welding pressure and the welding cycle is controlled automatically by a cam in the Geneva movement of the table. Located within the nitrogen chamber are four switches that give the operator full control of the system.

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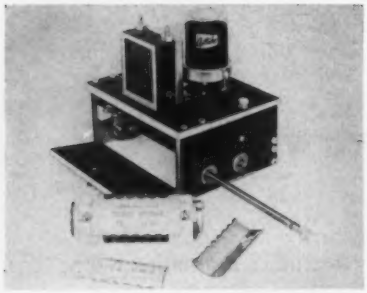

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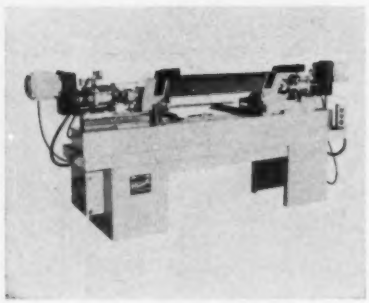


DOUBLE END THREAD ROLLING MACHINE

Size A Holomatic double end thread rolling machine automatically rolls threads on both ends of steel, aluminum, and brass rods at the rate of up to 3000 parts per hour (6000 threads). Threads in sizes from 6-40 to $\frac{7}{8}$-9 up to 4 inches long can be rolled on rods from 5 to 76 inches in length. This air-powered, hydraulically fed unit is used to power self-opening, end-feed-type thread rolling heads. An operator is required only to place rods in the magazine storage arms; the machine automatically escapes, locates, clamps, thread rolls, unclamps, and ejects the parts in proper sequence. Setup for various length parts can be made in a matter of minutes by moving either or both of the independent fixture-power feed unit assemblies along a full length aligning keyway. **Hause Machines Inc.**, Montpelier, Ohio.

Circle 403 on Reply Card

ANALOG CONTROL COMPUTERS OF TRANSISTORIZED MODULAR DESIGN

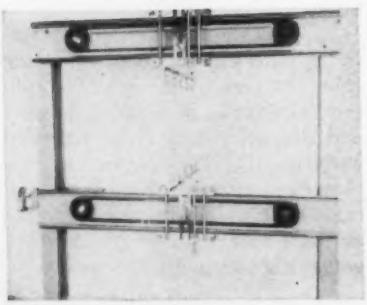
Line of special purpose analog PC-12 computers have been developed for fully automatic on-line control of various industrial processes. They are assembled from stock, solid-state modular designed components to meet particular requirements of chemical, steel, and other industrial processes. The computers simultaneously and instantaneously accept several inputs and compute several outputs based on complex mathematical relationships which apply to a particular process. They can be used in closed loop control or as advisory devices for operator guidance. **Electronic Associates Inc.**, Long Branch, N. J.

Circle 404 on Reply Card

VIBRATORY FEEDER DESIGNED FOR USE WITH AUTOMATIC PRODUCTION TOOLS

Self-contained vibratory feeder, designated Electrofeed, is used with automatic production tools for staking, punching, riveting, terminal setting, etc. It is easily adapted to other equipment as well, and feeds a wide range of small parts including rivets, terminals, and similar hardware automatically at rates of from 0-200 inches per minute, clockwise or counterclockwise. Through a potentiometer, a simple dial adjustment regulates the rate of feed. Feeder is available in bowl diameters of 8, 10, and 12 inches. **Black & Webster Inc.**, 570 Pleasant St., Watertown 72, Mass.

Circle 405 on Reply Card

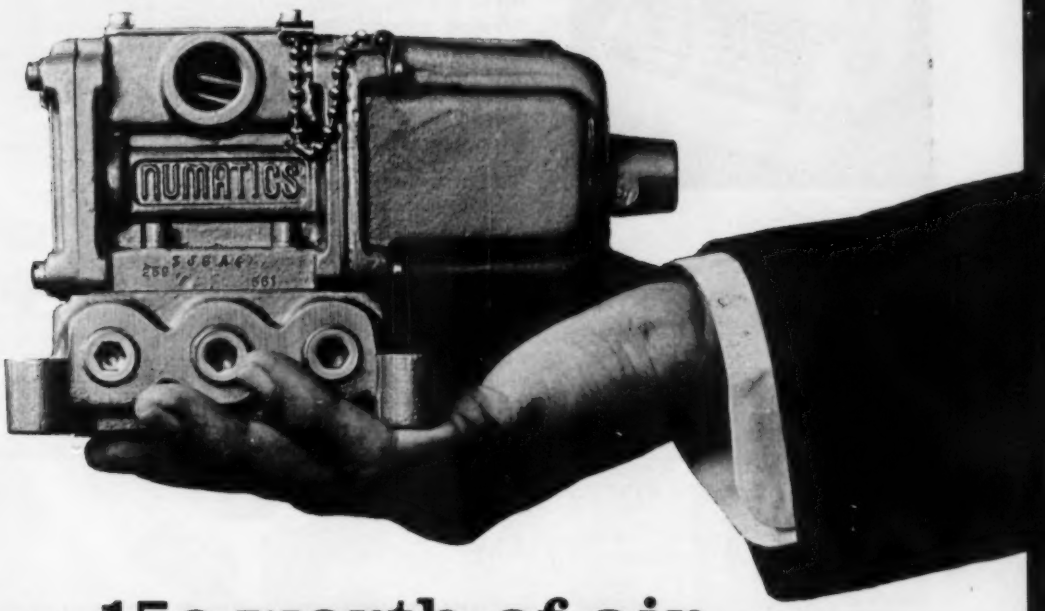


HIGH-SPEED RECIPROCATING UNITS FOR AIRLESS SPRAY APPLICATIONS

Line of high-speed transverse spray machines is designed especially for use with airless spray equipment. Illustrated is Model RTM-25 which features twin carriages with manifolded nozzles for up and down spraying. This model is useful in applications such as in the textile industry where high-volume/high-speed applications of coatings to both sides of a fast moving web are desired. It is fitted with two sets of five airless spray nozzles on each manifold, supplied with material from a high pressure paint valve. System permits use of multiple fast speed of reciprocation due to decreased carriage weight. Other models include single carriage units, vertical spray units, and twin head machines for two-component catalyst spraying. **Spraymation Inc.**, 25 Amity St., Little Falls, N. J.

Circle 406 on Reply Card

this air valve leaks



...15c worth of air

...in one year!

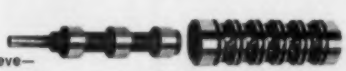
This valve leaks at a rate of about .003 C.F.M. or 15c worth of air in a year. During its unlimited service life the loss will drop to even less. Numatics valves *improve* with service. Unlike poppet valves, there is no blow by from intake to exhaust as the valve shifts.

So what?

You pay 15c a year to get rid of working resilient seals and the inevitable down-time that results from seal failure in an air valve, because the Numatics valve *has no working seals.* Its stainless steel spool and sleeve, fitted to *millionths* of an inch, needs no working seals!

Run it on any standard lubricant, or run it dry, the Numatics valve is the most reliable air valve on the market!

Buy some.



The lapped spool and sleeve—
it works, and works, and works!

NUMATICS, Inc.

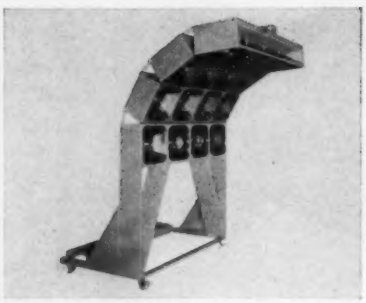
Highland, Michigan

Circle 692 on Reply Card

BINARY ENCODER UTILIZES STANDARD 44-KEY ALPHANUMERIC KEYBOARD

Photoelectric binary-encoding keyboard, designated K-144, features a photoelectric encoding technique which permits the generation of any standard or special, 5, 6, 7, or 8-bit binary code while at the same time completely eliminating all of the encoding matrices, contacts, and switches used in other keyboards. It operates in the following manner: When a key is depressed, an associated binary-coded shutter modulates a bank of light data channels. The resultant binary-coded light data produces resistive changes in a bank of photoconductors corresponding to the binary code used. Optional amplifier circuitry converts the photoconductor signals to electrical signals compatible with standard computer logic, thus permitting the keyboard to be used for on-line applications. **Invac Corp.**, 14 Huron Drive, Natick, Mass.

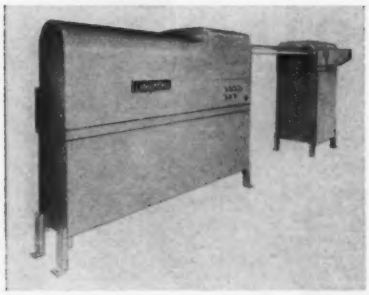
Circle 407 on Reply Card



ELECTRIC INFRARED PORTABLE HEAT PANELS

Capable of being formed into any size paint baking or curing oven design, these electric infrared portable heat panels can provide results equivalent to those obtained by custom-made process ovens. They are offered in a variety of widths and heights with the top sections hinged for inclining in an arc to form half an oven section. By placing similar units opposite one another, an oven of any size can be formed by merely rolling them into position and inclining each bank of units as desired. The panels can be obtained in four different reflector wattages from 125 to 500 watts, and heat sources of Chromalox Metarays or G-30 glass lamps. **Radcor Inc., Subsidiary, Edwin L. Wiegand Co.** Bradner, Ohio.

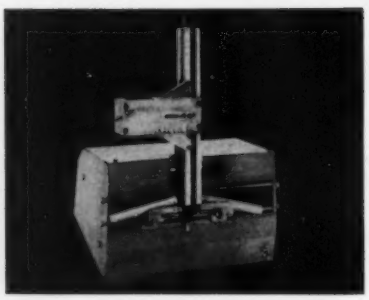
Circle 408 on Reply Card



MACHINE PROVIDES FOR CONTINUOUS ZONE REFINING OF GERMANIUM

Fixture for the continuous zone refining consists of an atmosphere charging chamber where a number of germanium-filled boats are placed on an indexing conveyor. The boats are then automatically charged into a quartz tube where multiple zones can be melted either by induction or resistance heating elements. The boats travel through the cycle powered by a precision drive screw. At the end of each push cycle an automatic high-speed return is activated. The boat is in contact with nothing but stainless steel in the cold state. An atmosphere discharge cooling chamber is provided on the exit end of the quartz tube. The unit is adaptable for various sizes of quartz tubes and boat lengths. **Lindberg Engineering Co.**, 2450 W. Hubbard St., Chicago 12, Ill.

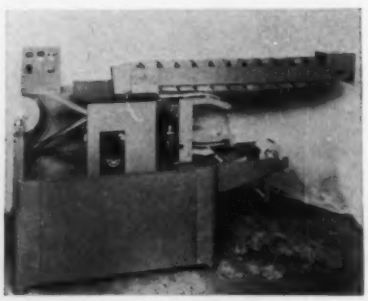
Circle 409 on Reply Card



PRODUCTION TOOL FOR CUTTING AND BENDING AXIAL LEADS

Bend-Amatic Model U dispenser cuts and forms the axial leads on any component swiftly, automatically, and accurately, yet does not remove the oxide from the leads. It will handle any axial-lead component having a body shape that can be stacked in a single-chute hopper and body length up to 1½ inches. Dispenser operates in either fully or semi-automatic mode. In full automatic it will cut and form 5400 components per hour. Less than 30 seconds are required to change from one body shape or bend configuration to another. Standard machine forms a 90-degree bend at any preset point in the lead, to as close as 0.090 inch from the component body. **Develo-Amatic Engineering**, 923 Industrial Ave., Palo Alto, Calif.

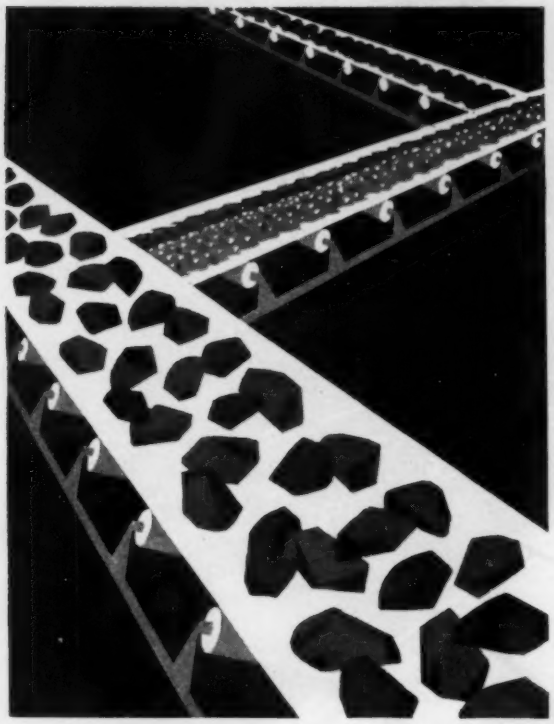
Circle 410 on Reply Card



POUCH AND STRIP PACKAGING MACHINES

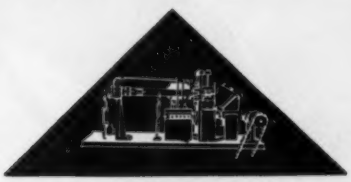
Pak-Rapid Model WHC pouch and strip packaging machines are ideally suited to meet the growing trend to pouch packaging of spare part kits, electrical components, hardware, and the strip packaging of pharmaceuticals. They produce pouch or strip packages from any heat sealable film, paper, or foil. Package sizes range from one to six inches in width and from one to eight inches in length. They may contain a single product or an assortment. Optional equipment is available for automatic or semiautomatic product feeding, printing, punching holes at the top of the packages for rack hanging, and for vacuum packaging. **Wright Machinery Co., Div., Sperry Rand Corp.**, Durham, N. C.

Circle 411 on Reply Card



...FOR ECONOMICAL
MATERIALS HANDLING

FAIRBANKS-MORSE BELT CONVEYOR SCALES



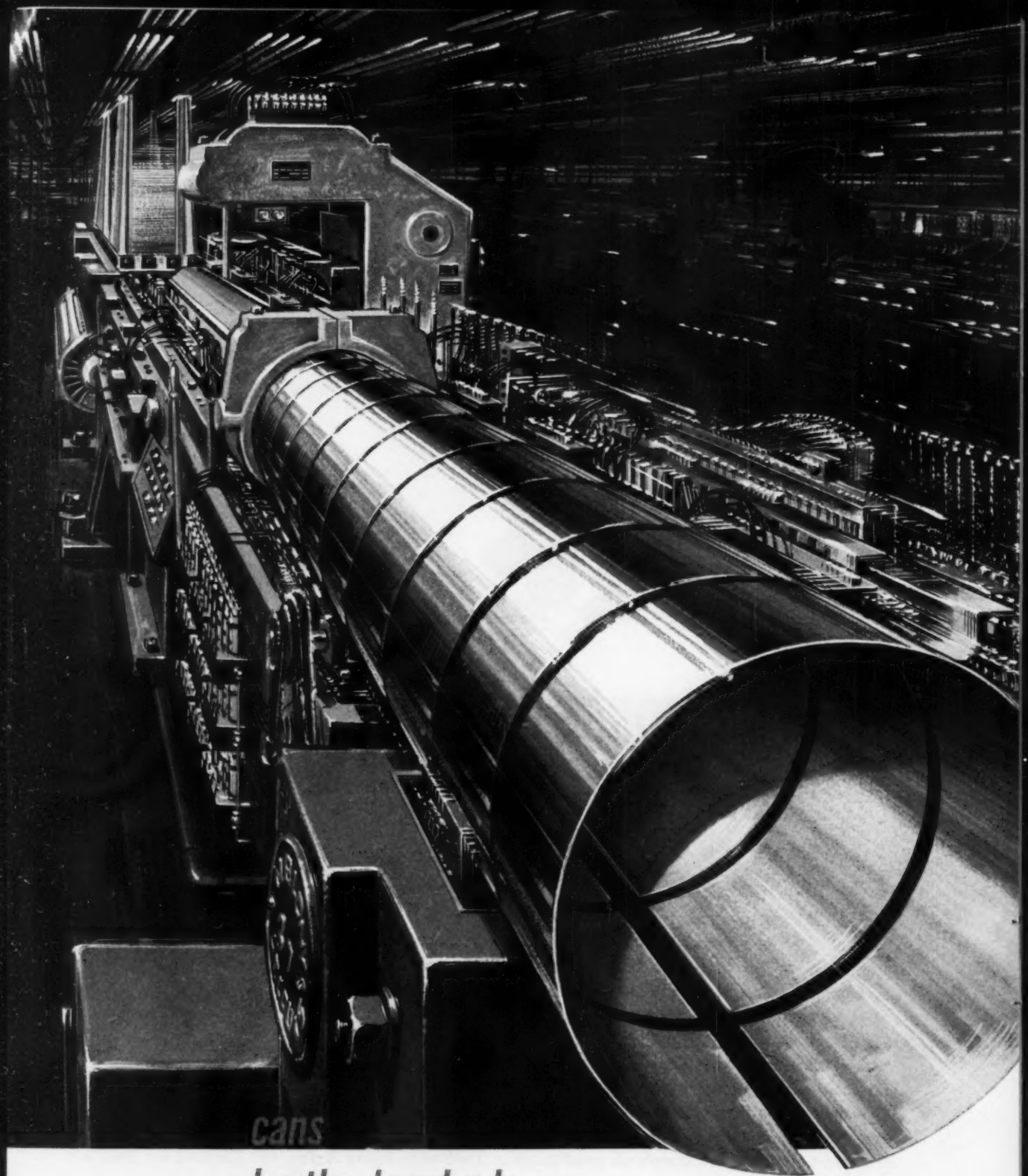
Now ore, minerals, concentrates, sludges and other materials can be quickly, easily and accurately weighed while they are passing by on conveyor belts. F-M specially designs belt conveyor scales for your specific needs... assuring accuracy and economy for your particular operation.

With F-M Belt Conveyor Scales you get simple and positive operation that automatically totals the weight of the materials carried by the conveyor. The accumulated weight is shown on the direct-reading register... there's no need to apply multipliers or conversion factors, and a means to provide a printed weight record is available.

The F-M Belt Conveyor Scale is simple in design and construction. The beam and integrating mechanism are housed in a dust-proof cabinet ... stainless steel and bronze parts mean minimum maintenance... aid in the over-all accuracy of the scale.

To learn how F-M Belt Conveyor Scales can save money for your operation, write: **For further information: Dept. S-1; Scale Division; Fairbanks, Morse & Co.; 100 Electra Lane, East Station; Yonkers, New York.**

FAIRBANKS MORSE
A MAJOR INDUSTRIAL COMPONENT OF
FAIRBANKS WHITNEY



by the hundreds
and no stops for greasing!

step up production

with Lincoln automatic lubrication

Automated lines run smoother, faster when each bearing gets its lubricant automatically. Take cans. A few years ago 300 cans per minute was considered a fine rate. Now if you don't get over 600 you're losing out.

Automatic lubrication makes a definite difference in your production rates. A bearing that gets a small, measured amount of grease every 15 minutes runs cooler and smoother than one that gets a big gob every eight hours. It holds up longer, and knocks out the biggest cause of unscheduled downtime . . . bearing burnout. You also use less lubricant and less power, and the smoother run reduces rejects.

Whether you build or buy machinery, you protect your investment with a Lincoln automatic lubrication system.

WHEN YOU THINK OF LUBRICATION . . . THINK OF LINCOLN

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ENGINEERING COMPANY
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☐ Please send me your new Catalog 82 on Lincoln centralized lubrication systems.

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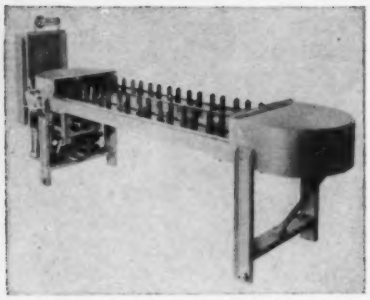

TRANSFER MACHINE CHASSIS FEATURES HIGH PRODUCTION RATES

Progressive assembly and testing of components on this unit are cycled at rates up to 2000 pieces per hour. Precision indexing is obtained from a cam-and-roller index drive plus a special close tolerance chain and platen linkage. Individual fixtures can be accurately located on any of the 26 platens within ±0.010 inch with anvil type, positive support in all directions for pressing, staking, etc. Positive shot-pin location of floating-nest fixtures can be included for extremely precise operations. Standard transfer machine chassis are available in 10 to 50 foot lengths. Three alternate index drives are offered: Mechanical cam-and-roller, hydraulic servo, and electromechanical. Range of indexing is from 3 to 18 inches. **Visi-Trol Engineering,** 12720 Burt Rd., Detroit 23, Mich.

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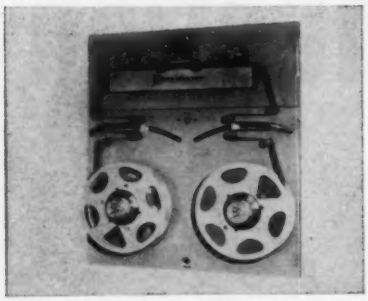

HIGH-SPEED BIDIRECTIONAL PERFORATED TAPE HANDLER

Dykor Model 4577 tape handler accepts 5 to 8 level tapes interchangeably. It permits forward or reverse reading of perforated tape at speeds up to 500 characters per second and rapid rewind at 1000 characters per second. This tape handler has been designed for use with a Dykor unidirectional Model 3500 or bidirectional Model B3500 high-speed photoelectric tape readers. It is suitable for rack mounting. Eight-inch reels hold 500 ft of 4.5 mil tape, or 100 ft of 3 mil tape, and are controlled by a three-zone contactor system which performs the same function as a full servo system. Bidirectional rewind is available as an option. **Digitronics Corp.,** Albertson Ave., Albertson, L. I., N. Y.

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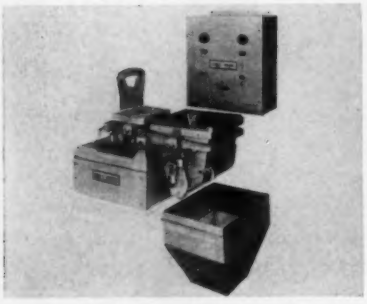
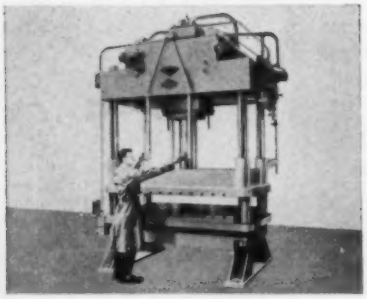


NET WEIGHING MACHINE CAN BE OPERATED SINGLY OR IN COMBINATION

Model 630 automatic net weighing machine has a 75-lb capacity. It consists of a heavy duty, even balance lever scale equipped with an air operated dump mechanism on the weigh hopper. The hoppers are available with capacities from ¾ to 2 cu ft. Fast responding scale has a control sensitivity to ½ oz accuracy and a dial that can be read to 1 oz. Simplified automatic adjustable controls are mounted on the scale for operating feeding equipment such as automatic valves, vibratory feeders, auger feeders, or conveyor belts. Optional equipment includes manual or air operated bag holders, portable stands, counters, alarm systems, automatic valves, and vibratory feeders with one or two rates of speed. **Exact Weight Scale Co.,** 541 E. Town St., Columbus 15, Ohio.

Circle 414 on Reply Card



TRIM PRESS EQUIPPED WITH ADJUSTABLE DECELERATION VALVE

This four-bar trim press is capable of exerting 100 tons of trimming stroke pressure. It is designed to overcome the limitations of mechanically operated presses by utilizing hydraulic principles. High-speed production results from the fast approach velocity of 900 ipm and a return speed of 875 ipm. The slow trimming action of 59 ipm produces neatly sheared, clean castings. Other features of the machine include a 36 by 72-inch die area, a supporting 52 by 88-inch base platen, safety stops on the tie bars, and a 30-inch stroke. **B & T Machinery Co., Div., Greenlee Bros. & Co.,** Holland, Mich.

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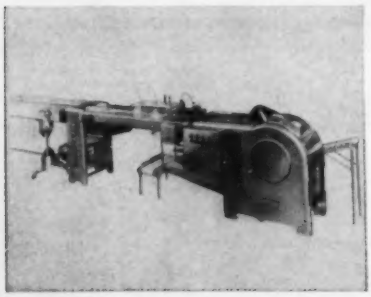
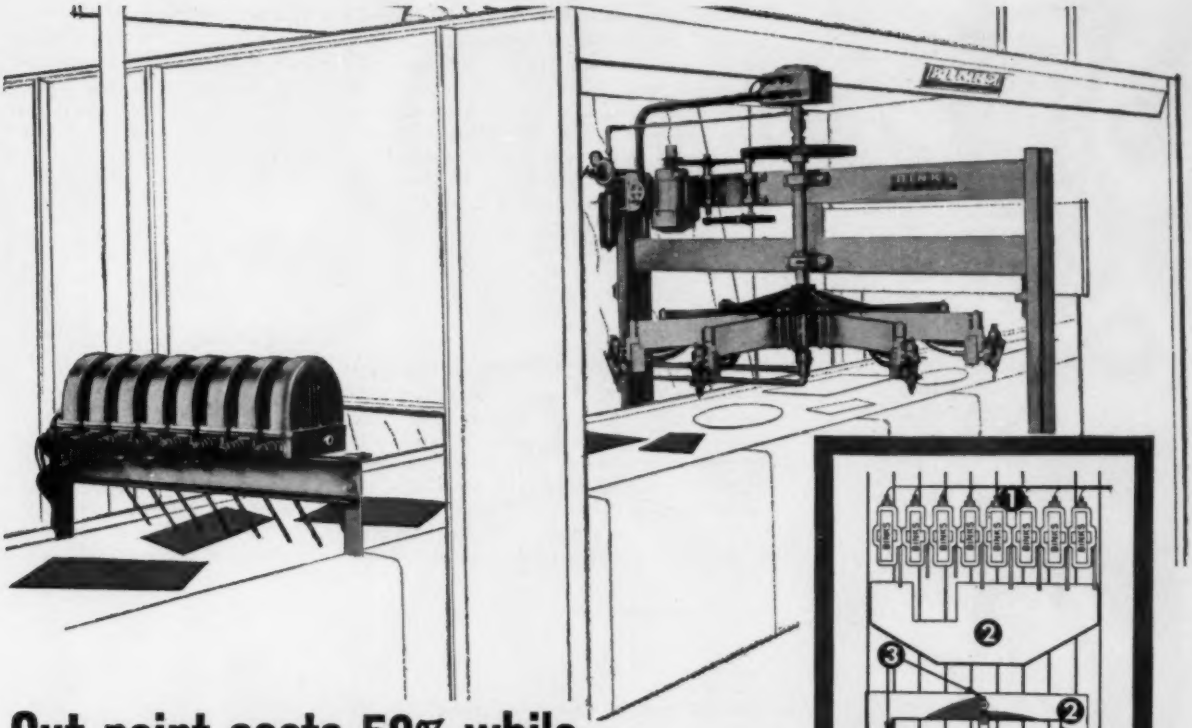


HORIZONTAL, CONTINUOUS SPEED PACKAGING MACHINE

Capable of forming, filling, and sealing bags at production rates of up to 100 units per minute without using any cards or stiffeners, this machine bridges the gap between vertical bag form-fill-seal equipment and standard overwrap machines. At the beginning of Model RT, the product rides up on a moving belt formed by a web of packaging material. The web is then folded up around the product and heat sealed to form a continuous tube. The tube is picked up and pulled around a large drum. As the tube containing the product is wound onto the drum, a sealing and cutoff die closes on the gap between the individual pieces of product. After a half turn on the drum, the package is completely heat sealed, cut loose, and deposited on a conveyor. **Hayssen Mfg. Co.,** Sheboygan, Wis.

Circle 416 on Reply Card



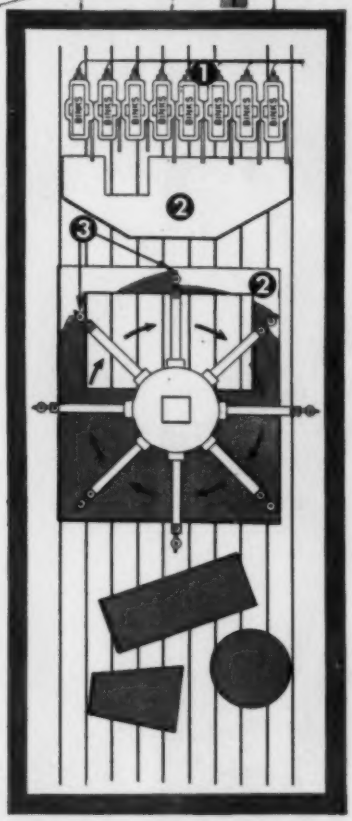
Cut paint costs 50% while spraying odd shapes up to 90 fpm

Tailor made automation at standard parts cost with Binks exclusive all new MEMORY TIMERS

Binks Memory Timer, a unique new electro-mechanical control mechanism, coupled with standard Binks spray equipment, gives you paint economies never before possible with automatic spraying . . . all without the expense of custom-made engineering.

The Memory Timer senses the size and shapes of objects passing beneath it on a conveyor and transmits the information to automatic spray guns. The rotating spray guns (available with 4 or 8 arms) operate only when the objects are in direct line of fire. Result: materials needed to finish a given run are drastically reduced (savings of 50% are not uncommon). Plus, you can spray up to 90 feet per minute with an 8-arm unit.

A precision instrument, the Memory Timer is unaffected by spacing timing and speed variations. Synchronized with conveyor movement, the timer stops, starts, increases or decreases speed without adjustments or resetting. Memory Timer units can be used singly, or in multiple units driven by a common drive to accommodate almost any conveyor width. Binks Memory Timer units are adaptable to most spraying machines already in service.



Here is how the system looks from above

(1) Binks MEMORY TIMERS astride your conveyor sense size, outline and location of (2) irregularly-shaped products to be sprayed and relay this information to (3) your automatically operated spray guns.

Ask about our spray painting school. Open to all . . . NO TUITION . . . covers all phases.

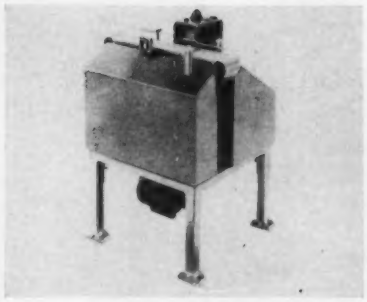
Binks Manufacturing Company 3132 Carroll Avenue, Chicago 12, Ill.

REPRESENTATIVES IN PRINCIPAL U.S. & CANADIAN CITIES • SEE YOUR CLASSIFIED DIRECTORY

Send for Bulletins A96-1R and A96-4 for complete information or, call your Binks representative; he's as close as your telephone.

1538

Binks Everything for spray painting



UNDERWEIGHT REJECTOR FOR DETECTION OF MISSING COMPONENTS

Suited to detection of missing components within packaged units, as well as rejection of underfills, Model UWR-1 automatic underweight rejector handles closed packages in a weight range up to 7 lb. It accomplishes 100 per cent rejection of all units under a predetermined weight, within an accuracy tolerance established by line speeds and product characteristics. As the package flow moves across the machine, a flipper reject mechanism discharges underweight units off the Mylar carrier belt. Speeds up to 300 packages per minute are achieved. Height of the unit is adjustable. **Illumitronic Systems Corp.**, 680 E. Taylor, Sunnyvale, Calif.

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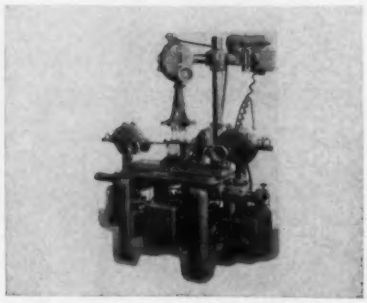
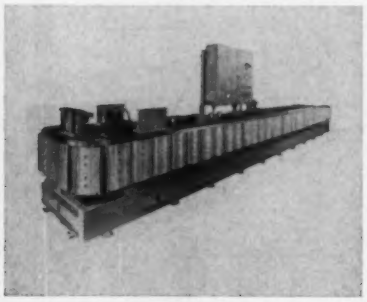


MULTI-HEADED DRILL MACHINE SUITABLE FOR A VARIETY OF JOBS

Multi-spindle machine can simultaneously drill, counter bore, tap and ream a workpiece from almost any angle. Designated Versi-Matic, it has heads that revolve 360 degrees both horizontally and vertically either on or under a worktable. The drill can perform as a special purpose machine for continuous runs. It can readily be rearranged to meet requirements of other jobs. Each head is individually powered and can be operated by automatic power or manual feed. Meeting any job requirement, spindles operate in sequence as well as simultaneously. Machine will accept all standard drill attachments, including a multi-drill head. **Van Norman Machine Co.**, Springfield, Mass.

Circle 418 on Reply Card



STRAIGHT-LINE INDEXING MACHINE CHASSIS

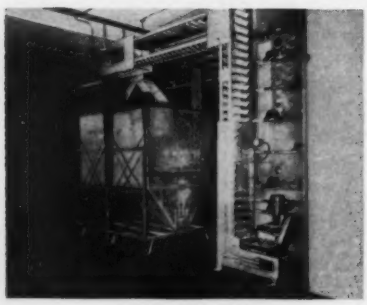
Heavy duty Auto-Tran straight-line indexing machine chassis is built as a standardized unit ready to accept customer's individual tooling. It is designed to accommodate extra-large, extra-heavy work without sacrificing cycle time. Unit is entirely self-contained and includes provision for tool mounting and hydraulic tool actuation. The chassis is furnished with drive motor, hydraulic pump and piping, and electrical wiring ready for tool application. The 30-foot long model has 70 vertical, cast aluminum work carriers, each 11½ inches wide by 18 inches high with a travel of 12 inches. It includes an electric clutch brake for cycle control, allowing infinite adjustment for the dwell (work performing) portion of the cycle. **Swanson-Erie Corp.**, 814 E. 8th St., Erie, Pa.

Circle 419 on Reply Card

BAG SEALER SEALS UP TO 80 BAGS PER MINUTE

Adaptable to all types of polyethylene bags and to many cellophane and cloth bags, automatic bag sealer features a closure device that adheres a special pressure-sensitive tape seal around the closure of the bags. Model S-605 is designed for a wide variety of bagged products including hardware items. It can seal bags up to 10 lb in capacity. Machine can operate in almost any position. The seal which is adhered instantly, consists of a short, one-piece length of pressure-sensitive tape. If desired, a shorter length of paper may be simultaneously and automatically laminated to the tape by the machine during sealing to form a Y-shaped paper tape for easy breaking of the seal. **Minnesota Mining & Mfg. Co.**, Dept. J1-2, 900 Bush Ave., St. Paul 6, Minn.

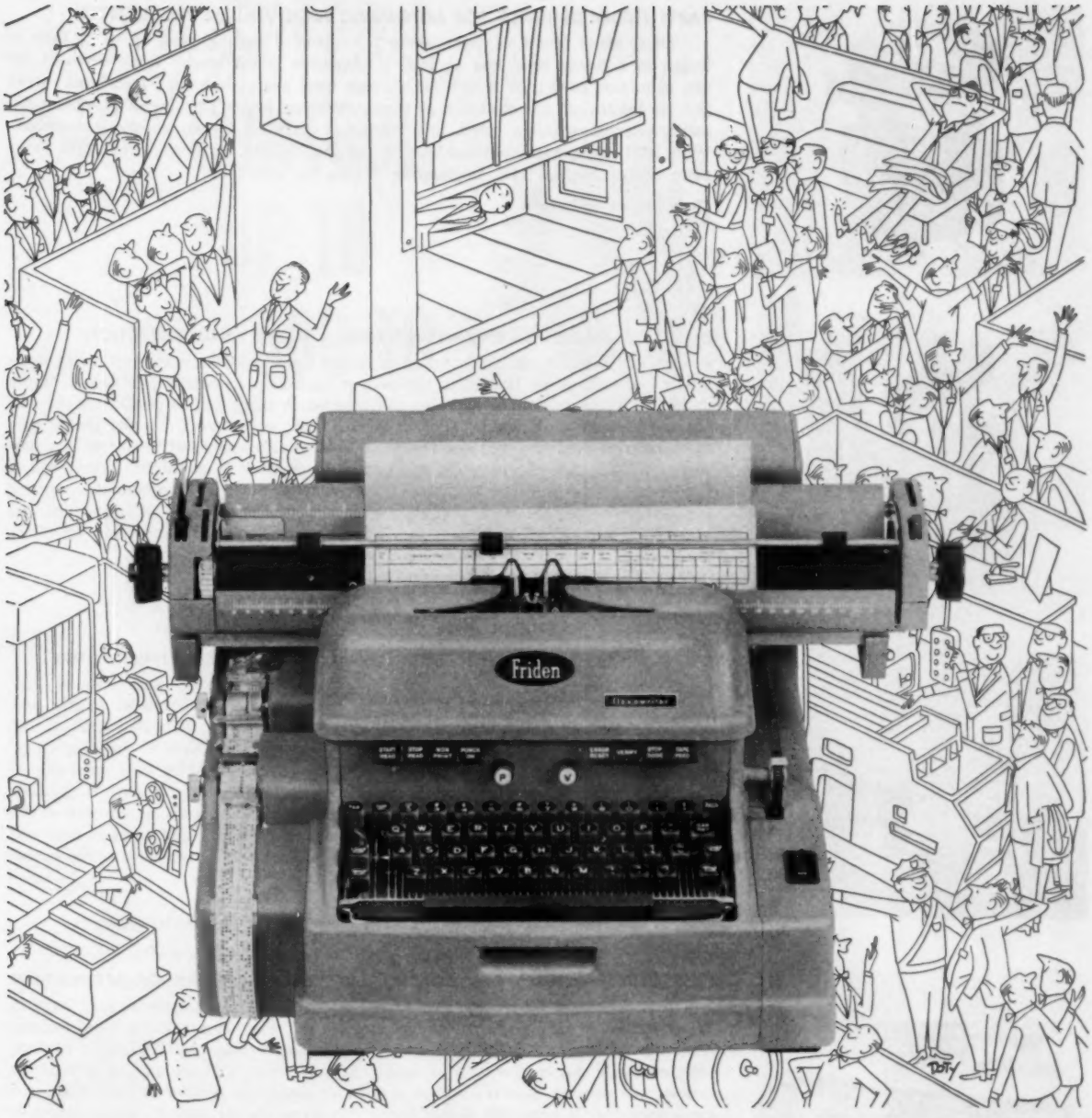
Circle 420 on Reply Card



CONVEYOR AVAILABLE IN THREE STANDARD BUCKET SIZES

Bucketglide conveyor, with automatic switchover discharge, fills portable storage bins with dried macaroni at 1500 lb per hour, 24 hours a day. Bucketglide feature of the conveyor prevents buckets from jamming, loosening, or falling out. This conveyor is available in 3 standard bucket sizes and custom built to requirements. **Clermont Machine Co. Inc.**, 280 Wallabout St., Brooklyn 6, N. Y.

Circle 421 on Reply Card



The Friden Flexowriter®: Machine Tool's Machine Tool

At the recent Machine Tool Exposition, approximately 80% of the numerically controlled tools on display featured 8-channel punched paper tape input.

The toolmakers have shown this overwhelming preference for punched paper tape for several reasons:

1) the tapes are easy to prepare,
2) the coding is visible,
3) tape can't get out of sequence,
4) tape is durable and unaffected by chance exposure to magnetic fields.

By standardizing on paper tape input for your numerically controlled tools, you get all the benefits listed above, plus one more: It's so much easier (and less expensive) when all of your numerically controlled tools can be programmed on one device. That device? The Friden NC-1 Flexowriter—the machine tool's machine tool.

THIS IS PRACTIMATION: Friden is the world leader in tape technology and the practical application of the automation it makes possible. For full information, call your local Friden Systems Representative. Or write: Friden, Inc., San Leandro, California.

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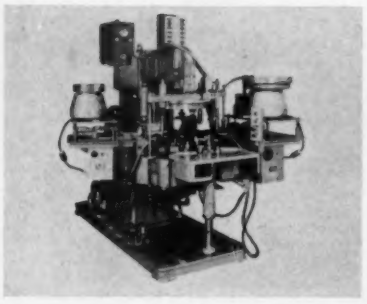
PARTS FEEDER DESIGNED FOR AUTOMATIC HIGH VOLUME PRODUCTION

Elk-O-Matic Model 51 parts feeder is capable of feeding parts up to ¼ inch in length in a 5-inch bowl and ½ inch in length in 7-inch bowl. Track width of the cast aluminum bowl is 5/16 inch for a 5-inch bowl and ½-inch for 7-inch bowl. Bowl can be constructed for clockwise or counterclockwise feed. This feeder provides automatic, oriented position, single line feeding of parts to various automatic machines. With 3600 electromagnetic vibrations per minute, delicate parts can be fed with minimum risk of damage. **Elk Engineering Works**, St. Marys, Pa.

Circle 422 on Reply Card



DIAL TYPE MACHINE COMBINES ASSEMBLY, SIZING, AND INSPECTION

Assembly chassis (42-30) is tooled to perform the following operations on an automotive valve: On the first pass, the part is nested in a vertical position, a bronze bushing is hopper fed into the valve and inserted. A sizing ball is pushed through the bushing and the bushing I.D. is then checked with an air gage. On the second pass the part is removed from the nest fixture and placed over a mandrel fixture while a new part is inserted into the nest. On this pass a check valve is assembled. A steel ball is hopper fed in the valve body. At the next station a coil spring is wound on a spring winder and blown into place. The part is then inspected. A roll pin is hopper fed and inserted. The completed part is removed from the dial. **Bodine Corp.**, 317 Mt. Grove St., Bridgeport 5, Conn.

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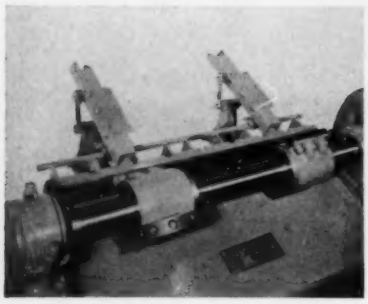

SCRAP CHOPPER ENGINEERED ESPECIALLY FOR STRIP STEEL SLITTING LINES

Scrap chopper has been developed for cutting up trimmed edge material that results from slitting of coiled stock. The scrap edges are cut into short lengths and discharged into a box or conveyor for easy removal. Scrap from the slitter is fed through adjustable steel chutes and is discharged over the fixed blade of the scrap chopper. The cutter heads, quickly adjustable for varying strip widths, trim the scrap as it is fed forward. The entire scrap chopper assembly including motor drive is mounted on wheels running on a track in the floor so that it can be moved to one side of the line to permit access to the slitter for knife setup. Because the unit employs relatively short blades, costs of replacement or regrinding are kept to a minimum. **Production Machinery Corp.**, Mentor, Ohio.

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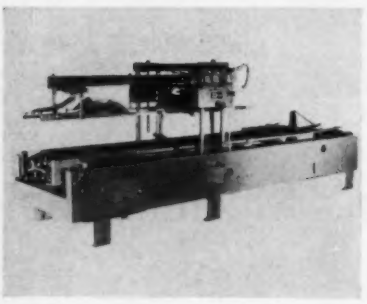

CASE GLUER FEATURES CASE-CONTROLLED SKIPGAP PATTERN OF APPLICATION

Unit, designated Model SK-455, economizes on glue usage by applying it in uniform stripes instead of solid coatings. Neater cases are the result of a case-controlled skipgap pattern of application that prevents glue from dripping through the slots onto a product. Unit does not spatter glue and so keeps the area under and around the glue much cleaner. In operation, glue is fed from a reservoir under low pressure through hoses and applicators directly onto case flaps. Glue is exposed to the air only at the moment it is applied. When the unit is not in use, the applicators rest on moist pads which prevent glue from hardening on or inside them. The unit is thus ready to operate without make-ready or setup time. **Portland Div., Emhart Mfg. Co.**, Portland, Conn.

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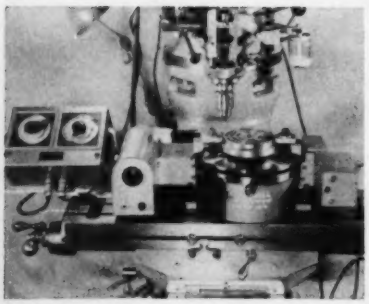

ELECTRONIC INDEXING TABLE

Designed for automatic spacing of hole patterns in degrees, one-half degree or one-tenth degree increments, the 800 Roto Mill electronic index table can also be used for programming a part that requires milling slots. Typical applications include drilling, boring, jig boring, checking, milling, spacing, etc. By use of a 15-inch program plate, the table can program uneven indexes. It can be used in either vertical or horizontal position. **M & M Tool Mfg. Co.**, 1124 E. Third St., Dayton, Ohio.

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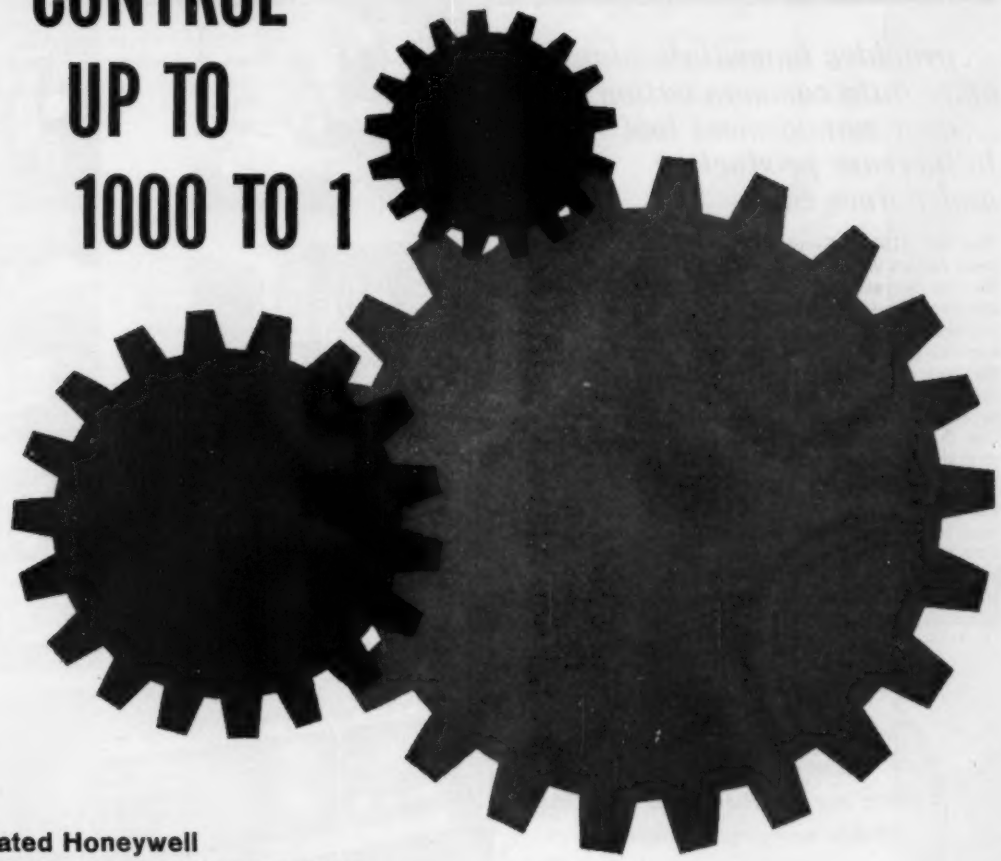
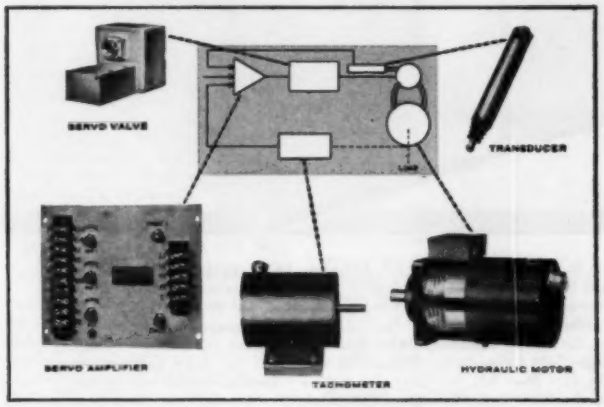
SPEED CONTROL UP TO 1000 TO 1



Integrated Honeywell speed servo control systems assure smooth, steady operation!



A matched Honeywell Speed Control system can assure you of precision control at any speed. Based on the "building block" concept, a Honeywell system is easily adaptable to a wide range of industrial uses. The basic components of a Honeywell Speed Control system are proportional servo amplifiers, transducers and electro-hydraulic servo valves. Each Honeywell component has been compactly designed and ruggedly built to insure long-life and continuous reliability.

In addition to their sturdy construction Honeywell Speed Control systems offer negligible droop under load fluctuations and smooth, steady low-speed operation.

For details on any or all of Honeywell's Speed Control systems, write Honeywell, Dept. 1061, Minneapolis 8, Minnesota.

Honeywell

First in Control

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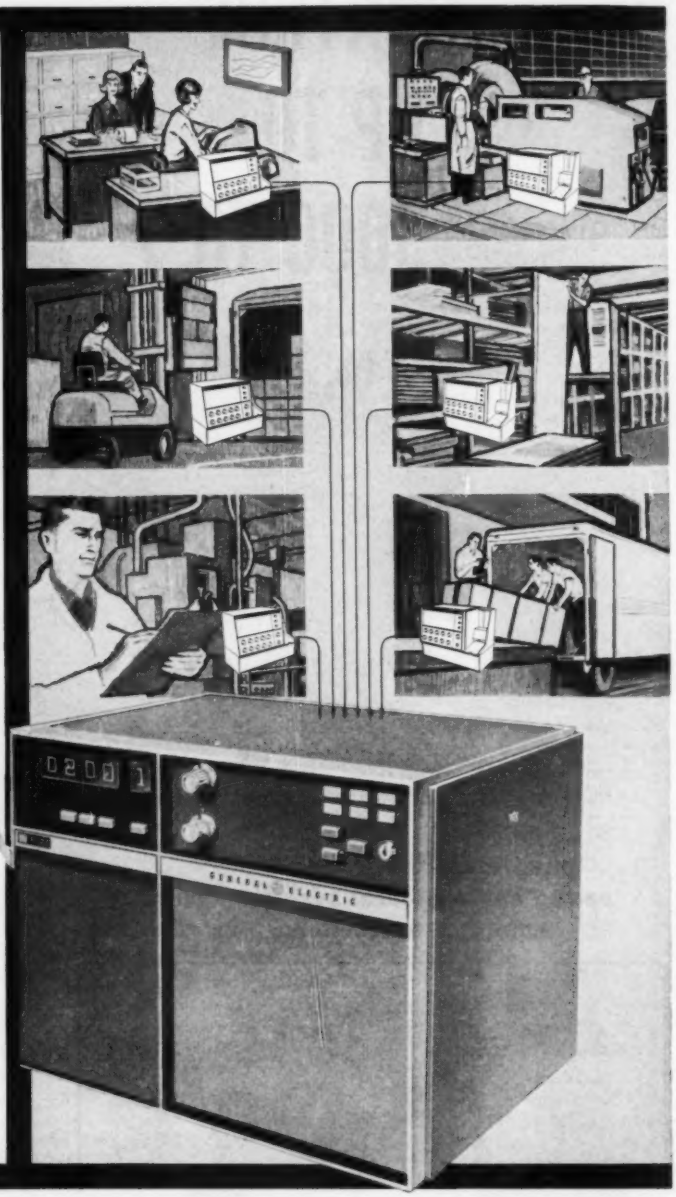
New GE 3101 DATA ACCUMULATION and COMMUNICATION system...

...provides immediate plant/ office data communication ...as a management tool to increase production and reduce costs.

The GE 3101 is General Electric's answer to the need for an economical and effective means of collecting operational data. Key areas such as purchasing, receiving, quality control, shop operations, warehouse, shipping, etc., send current data to a central point for collection and display. Each of the key areas has a Collector that sends data to the Accumulator, where it is punched into paper tape for a permanent record. Data originating at the Collector is from punched cards and/or 19 variable dial settings. Collectors may be up to 10,000 feet from the Accumulator.

The punched paper tape can produce a typewritten copy immediately for visual display of current conditions; can be converted to punched cards; or can be used for direct input to a computer system. Investigate this new, lower cost development by General Electric.

Installation of the GE 3101 information gathering system can result in greater operational profits due to: accuracy and timeliness of data, economy of operation, and quicker access to the facts for well informed decisions by management.



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AUTOMATION

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421	451	481	511	541	571	601	631	661	691	721	751	781	811	841	871
422	452	482	512	542	572	602	632	662	692	722	752	782	812	842	872
423	453	483	513	543	573	603	633	663	693	723	753	783	813	843	873
424	454	484	514	544	574	604	634	664	694	724	754	784	814	844	874
425	455	485	515	545	575	605	635	665	695	725	755	785	815	845	875
426	456	486	516	546	576	606	636	666	696	726	756	786	816	846	876
427	457	487	517	547	577	607	637	667	697	727	757	787	817	847	877
428	458	488	518	548	578	608	638	668	698	728	758	788	818	848	878
429	459	489	519	549	579	609	639	669	699	729	759	789	819	849	879
430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880

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401 431 461 491 521 551 581 611 641 671 701 731 761 791 821 851
402 432 462 492 522 552 582 612 642 672 702 732 762 792 822 852
403 433 463 493 523 553 583 613 643 673 703 733 763 793 823 853
404 434 464 494 524 554 584 614 644 674 704 734 764 794 824 854
405 435 465 495 525 555 585 615 645 675 705 735 765 795 825 855
406 436 466 496 526 556 586 616 646 676 706 736 766 796 826 856
407 437 467 497 527 557 587 617 647 677 707 737 767 797 827 857
408 438 468 498 528 558 588 618 648 678 708 738 768 798 828 858
409 439 469 499 529 559 589 619 649 679 709 739 769 799 829 859
410 440 470 500 530 560 590 620 650 680 710 740 770 800 830 860
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414 444 474 504 534 564 594 624 654 684 714 744 774 804 834 864
415 445 475 505 535 565 595 625 655 685 715 745 775 805 835 865
416 446 476 506 536 566 596 626 656 686 716 746 776 806 836 866
417 447 477 507 537 567 597 627 657 687 717 747 777 807 837 867
418 448 478 508 538 568 598 628 658 688 718 748 778 808 838 868
419 449 479 509 539 569 599 629 659 689 719 749 779 809 839 869
420 450 480 510 540 570 600 630 660 690 720 750 780 810 840 870
421 451 481 511 541 571 601 631 661 691 721 751 781 811 841 871
422 452 482 512 542 572 602 632 662 692 722 752 782 812 842 872
423 453 483 513 543 573 603 633 663 693 723 753 783 813 843 873
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426 456 486 516 546 576 606 636 666 696 726 756 786 816 846 876
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428 458 488 518 548 578 608 638 668 698 728 758 788 818 848 878
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429 459 489 519 549 579 609 639 669 699 729 759 789 819 849 879
430 460 490 520 550 580 610 640 670 700 730 760 790 820 850 881

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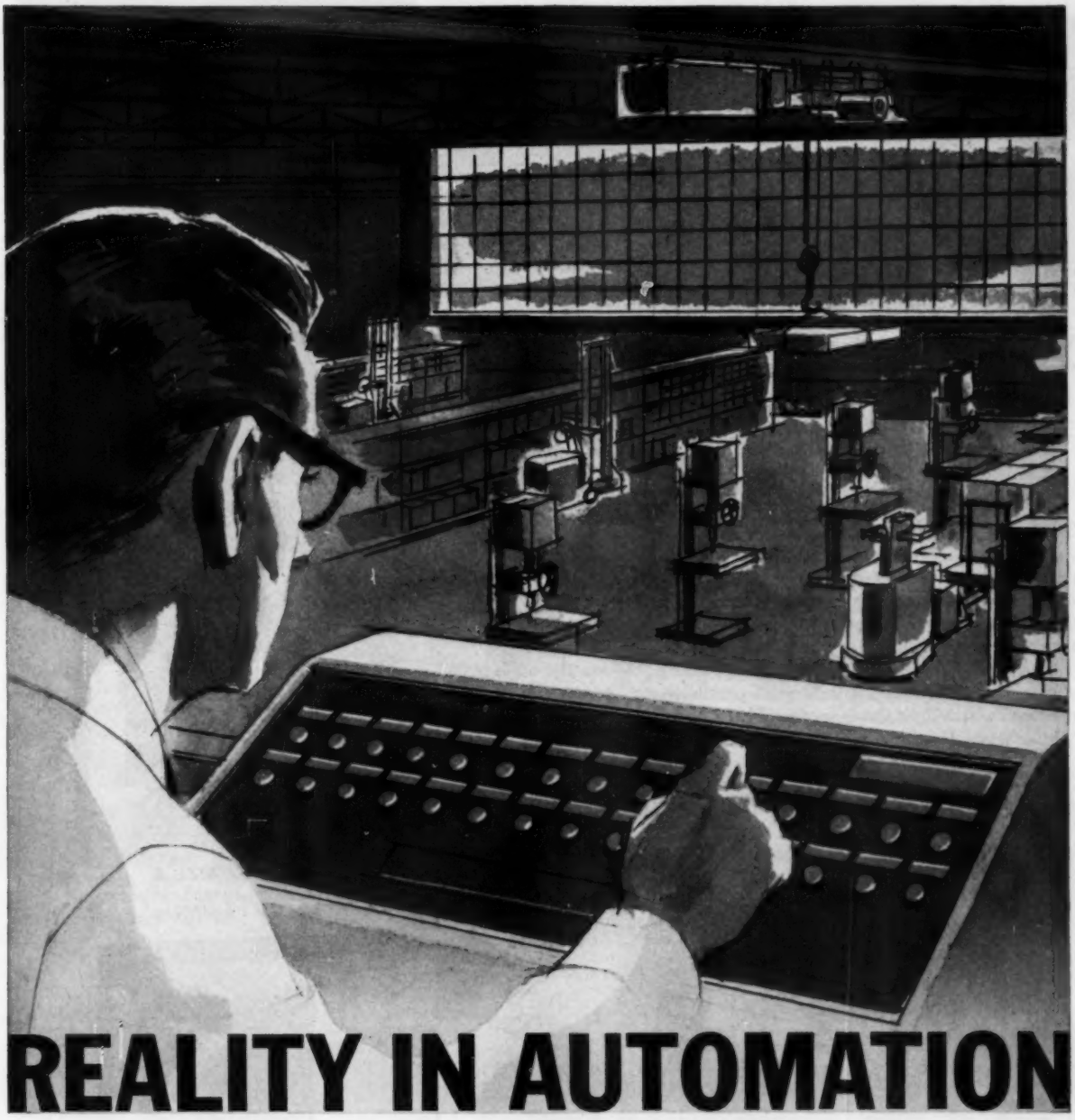

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MORE OF THE QUALITIES YOU NEED

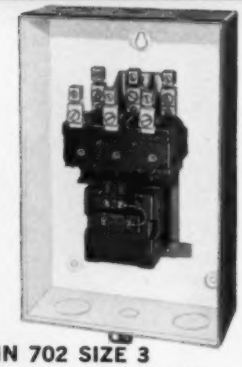
BULLETIN 709 SIZE 3
across-the-line solenoid starter in Nema Type 1 enclosure.

Where else could you possibly obtain—in one complete line—all of the desirable features of the ideal motor control...

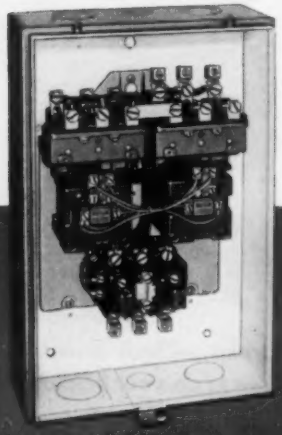
1. **Smaller size**
2. **Greater reliability**
3. **Remarkable switching capacity**
4. **Longer life**
5. **Conscientious overload protection**
6. **Simpler installation**
7. **Complete accessibility**
8. **Beautiful appearance—either open or enclosed**
9. **Surprising light weight**

The heart of this new line of magnetic motor starters is the unique solenoid contactor. While it retains the famous A-B one-moving-part principle, it is completely new and far more efficient. This fact is reflected in reduced dimensions for all of these controls. Yet, this contactor design will perform reliably for many more *millions* of trouble free operations.

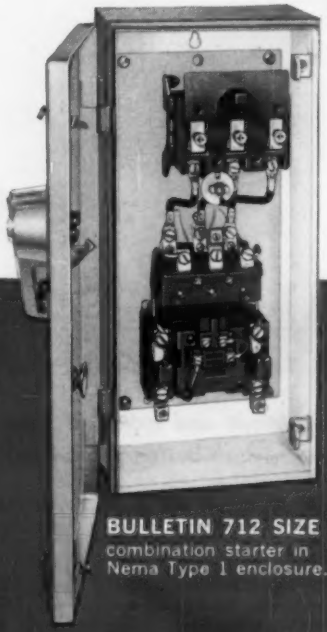
The new enclosures are very "eye appealing." When the open type starters are assembled into special panels, their neatness and compactness will delight the designers. Full details are in Publication 6100. Write: Allen-Bradley Co., 1339 S. First St., Milwaukee 4, Wis.



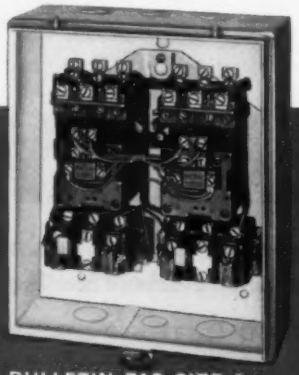
BULLETIN 702 SIZE 3
three-pole, a-c solenoid contactor in Nema Type 1 enclosure.



BULLETIN 705 SIZE 2
across-the-line reversing starter and overload relays in Nema Type 1 enclosure.



BULLETIN 712 SIZE 2
combination starter in Nema Type 1 enclosure.



BULLETIN 715 SIZE 1
across-the-line, two-speed starter—with two overload relays per speed—in Nema Type 1 enclosure.

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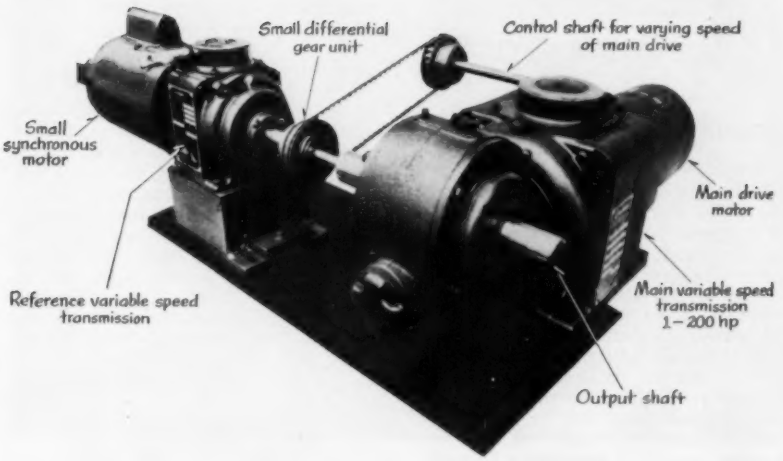
Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use Readers' Reply Card.


Small differential gear unit
Control shaft for varying speed of main drive
Small synchronous motor
Main drive motor
Reference variable speed transmission
Main variable speed transmission 1–200 hp
Output shaft

Differential gear unit is directly connected to both the reference variable speed transmission on the left and the main variable speed transmission on the right. When the main drive speed varies from the reference speed, the differential output corrects the main drive speed by adjusting the main transmission through the control shaft.

Closed Loop Speed Control System

INFINITELY variable, closed loop speed control system can be provided at low cost by using a technique developed by **Graham Transmissions Inc.**, Menomonee Falls, Wis.

As shown in the illustration, one end of the output shaft of the main variable speed drive is directly connected to a small differential gear unit. Also connected to the differential is a small infinitely variable speed transmission which is driven by a synchronous motor. Output from the differential is belt-connected to a control shaft which is used to vary the speed of the main drive.

In operation, the small variable speed drive provides a reference speed to the differential gear unit. When the reference speed matches the main drive speed, there is no output from the differential. However, when the main drive speed is more or less than the reference speed, the differential provides an output, causing the control shaft of the main drive to rotate and increase or decrease the speed of the main drive. Exact speed holding under widely varying load conditions is possible with the system.

The system permits a small and relatively inexpensive, but extremely precise, transmission, to be used as the reference unit. The main driving transmission may have little precision and may thus be quite inexpensive for its size since its speed can be maintained with great precision by means of the differential drive.

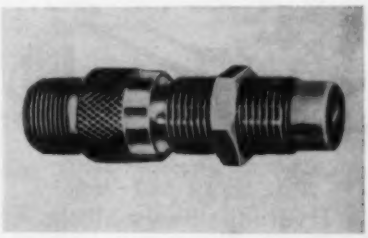
A Graham transmission is particularly suitable for the reference drive since it provides all speeds from maximum to zero with precise holding and reset. Speed will not change with extended use and is not affected by temperature changes. A variety of controls are available, including mechanical, pneumatic, and electric, for easy programming of the variable speed transmission.

Circle 427 on Reply Card

Screw Assemblies

Line of ball-bearing screw assemblies provides high load carrying capacities with minimum size, power, and cost. Mechanical efficiencies range from 90 to 95 per cent, and there is no tendency for the units to creep under load. Washers provide a method of limiting the travel of the nut at predetermined positions, with continuing rotation of the ball bearing screw. A set of three washers, two steel and one nylon, replaces each stop-pin. In addition to being less expensive, the stronger washers eliminate any danger of breakage. The actuators are ideally suited as a means of overload protection or for accurate position. They can also be used as holding devices, forward-stop-reverse systems, or stepless control units. **Saginaw Steering Gear Div., General Motors Corp.**, Saginaw, Mich.

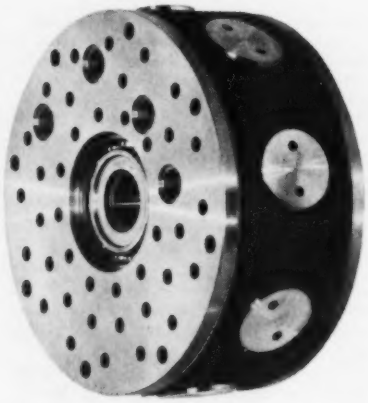
Circle 428 on Reply Card



Magnetic Pickup

Model 3045 is designed to generate voltage when excited by magnetic metal objects. As a self-generating input transducer, it provides a link between mechanical motion and instrumentation without mechanical contact. When a ferrous metal projection interrupts the external magnetic field, the pickup will generate voltage and current that can actuate electrical or electronic circuitry without amplification and without the aid of additional power sources. This device may be used with gear teeth of 20 pitch or greater. It will generate voltage/frequency in proportion to the speed of the metal teeth inter-

In another week this motor will complete one revolution



Why so slow?

Because tracking radar–
Radio telescopes–
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All need this servo motor

. . . that will rev up to 500 rpm and throttle down to 1/60,000 rpm . . . accelerate up to 40,000 radians per sec. per sec. . . . work at sensible 500 psi . . . stay rock stiff (no gears, no backlash).

Cimtrol's unique Acradrive
22 cu. in., 8 cylinder radial
Hydraulic Servo Motor

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The Cincinnati Milling Machine Co.
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CIMTROL

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rupting its magnetic field. This power is ample to operate many readout devices to help solve a wide range of speed measurement and control problems. **Electro Products Laboratories Inc.**, 4500 N. Ravenswood Ave., Chicago 40, Ill.

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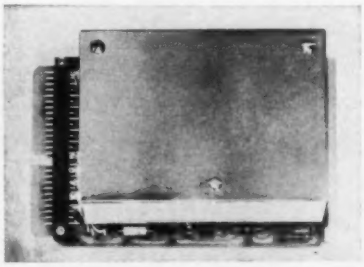
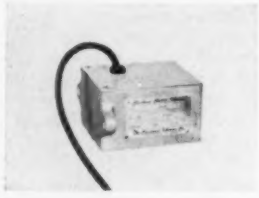


Acoustic Serial Memory

Digital serial memory with pulse delays ranging from 20 to 100 microseconds at operating frequencies of 8 to 16 mc is now available in a compact, self-contained plug-in package. Designated the SM-40, this unit provides storage at rates as high as 16 megabits per second, without need for carrier modulation. It contains all necessary input-output logic and is fully compatible with existing H-Pac digital modules for the implementation of complete serial memory systems. Device uses a fused silica acoustic delay line with a temperature coefficient that approaches zero (±2 ppm/degree C maximum) thereby obviating the requirement for temperature control. It has been designed to operate at rates up to 20 mc. Operation at rates up to 30 mc is also possible. Applications include serial memory, circulating storage, and precision timing. **Computer Control Co. Inc.**, 983 Concord St., Framingham, Mass.

Circle 430 on Reply Card



Electric Vibrator

Designed for continuous or intermittent service on light duty applications, the MC-2 electric vibrator is ideal for use on small bins, chutes, and hoppers. It features an external mechanical air gap adjustment which changes vibration intensity with the turn of a bolt. This will vary intensity of vibration at a frequency of 3600 vibrations per minute. Cast aluminum body of the vibrator attaches with two cast feet which eliminate the need for a special mounting base. The vibrator is equipped with a 6-foot cord, on-off switch, and a ground wire. **Cleveland Vibrator Co.**, 2828 Clinton Ave., Cleveland 13, Ohio.

Circle 431 on Reply Card

Solution Metering Pump

Pump is useful for application where small quantities of fluids must be precisely measured, including such work as dry infusion studies, organic synthetic research, reaction rate studies, or pilot plant operations. It is available in four ranges: 0-2, 0-5, 0-10, or 0-20 milliliters per minute. A simple turn of a precalibrated knob, which reads to thousandths of a milliliter per minute, sets liquid flow with an accuracy of ±2 per cent of the pump's full range. Repeatability is better than ±0.5 per cent of rated capacity. Internal components of the pump are constructed of highly inert materials to permit the handling of most corrosive fluids, and to prevent solution contamination. **Scientific & Process Instruments Div., Beckman Instruments Inc.**, 2500 Harbor Blvd., Fullerton, Calif.

Circle 432 on Reply Card

Graphite Control Valve

Designed especially for corrosive service, or where thermal shock is a factor, this single seated control valve utilizes impervious graphite in its split-body construction. It is furnished with studs for standard A.S.A. flange mounting and is recommended for use at operating temperatures to 340 F at pressures to 75 psi. Valve port diameters available are ½, ¾, 1, 1¼, and 1½ inches. **Falls Industries Inc.**, Aurora Rd., Solon, Ohio.

Circle 433 on Reply Card

Plastic Thermocouple

Line of thermocouples, designated Model P, utilizes a new design concept whereby it is possible to fabricate the body of

This man...
is running this locomotive

There is no one in the locomotive. The man in the picture can speed up, slow down, stop or reverse this train, *whether he is riding the locomotive or walking, or standing on the ground.* Both he and the locomotive are equipped with a new Union Switch & Signal remote control system for industrial switching locomotives. Because the operator always can be at the best vantage point, blind operations are eliminated and cars are spotted for loading, unloading or dumping more efficiently. This man can put a car *precisely* where he wants it.

You can minimize the hazards involved as freight moves around your plant with this unique remote control system. If you have a special problem such as moving cars into a thawing pit or under a loading chute, use a centrally located console control unit so one man has complete control over the entire operation.

Look over your in-plant locomotive operation and see if it couldn't be made safer and more efficient if the man running the train could always see what he was doing. Check the coupon for our illustrated Bulletin 187 on how our remote control systems can work for you.

Union Switch & Signal **A**
Division of Westinghouse Air Brake Co.
Pittsburgh 18, Pennsylvania

☐ Please send Bulletin 187 on Union Switch & Signal remote control systems.

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DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY—
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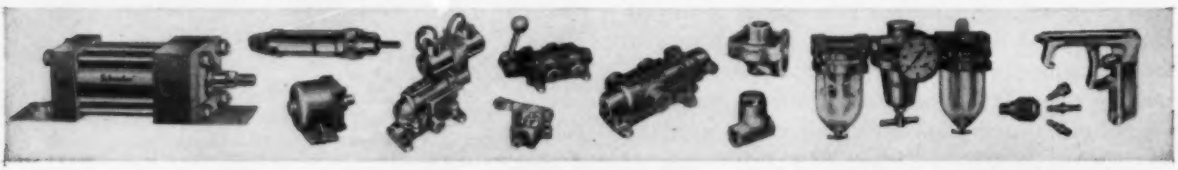
There's a quality difference in any Schrader Air or Fluid Product

EXAMPLE: Schrader Square-end Cylinders not only have quality built into every part, but feature many extras. For instance, the unique cartridge-type bronze bearing assembly (A) is easily removed by releasing just one retaining ring—no need to dismantle the entire cylinder for bearing maintenance. Special "step" design cylinder seal (B) assures perfect alignment and positive seal without danger of gasket damage. Below surface cushion adjusting screws (C) are protected from damage but fully accessible. They lock to eliminate loosening due to vibration.

Interchangeable with all JIC cylinders, Schrader also provides a variety of mountings. Special bushings are available for bone-dry piston rod in hydraulic operation.

ANOTHER EXAMPLE: Schrader's new direct action Hydraulic Gauges without mechanical linkage (A) eliminate fatigue failure of internal parts. They can withstand 100% overload without damage to accuracy, and are triple-damped (B) to eliminate indicator oscillation from pump pulses, surges, or shock that would damage other types. Can be maintained and calibrated easily in the field. PSI pressure ranges 0-500, -1500, -3000, and -5000.



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472 Vanderbilt Ave., Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS

the thermocouple from the same material as the wall of the test vehicle under study. This concept provides accurate surface or in-wall temperature measurements. The matching of materials eliminates errors due to differences in the thermal properties at the point of measurement. This line of thermocouples has been successfully fabricated from plexiglass, teflon, asbestos phenolic, micarta, graphite, copper, molybdenum, and tungsten. These thermocouples feature a response time of less than 10 millionth of a second to transient flow, a temperature range from −320 F to over 5000 F, an operating pressure range of 3000 psi and above, and have sensing tips with unlimited life. **Nanmac Corp.**, Dept. 11, P. O. Box 8, Indian Head, Md.

Circle 434 on Reply Card

Magnetic Hold-In Switch

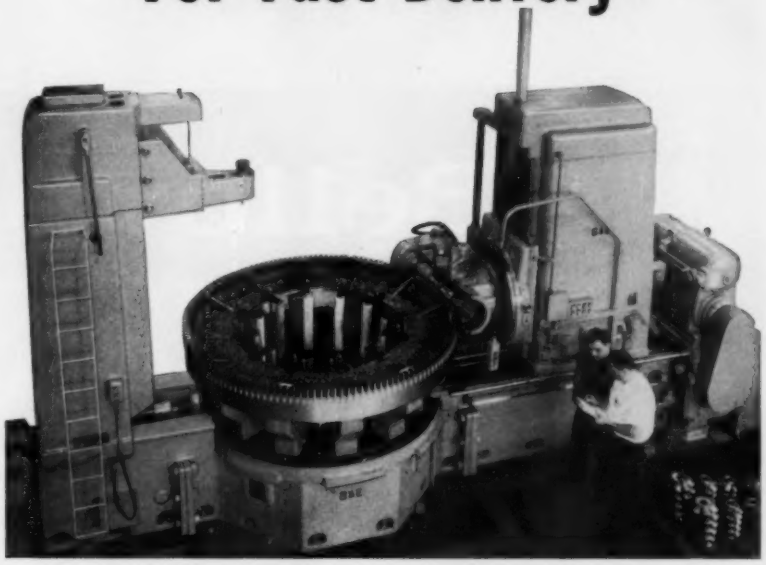
Equipped with a built-in solenoid, this magnetic hold-in switch permits electrical release from a remote location. When the toggle lever is operated and the solenoid is energized, the lever stays in the actuated position until it is released manually or electrically by de-energizing the solenoid. Environment-proof enclosure (a slender one-inch diameter housing) makes the switch ideal for locations where space is limited. The enclosure is filled with an inert gas under pressure to assure constant operating characteristics regardless of atmospheric pressure variations. Electrical rating of this DPDT switch is 28 volts dc at 24 amperes inrush (which is also the solenoid capacity); 4 amperes resistive; 2.5 amperes at sea level (sealed) and 2.0 amperes at 65,000 ft (unsealed) inductive; 4 amperes motor. **Micro Switch Div., Minneapolis-Honeywell Regulator Co.**, Freeport, Ill.

Circle 435 on Reply Card

Rotary Manifold

Miniature rotary manifold, Model MRM-6 is ideal for distributing air or liquid supply from a fixed center column to work-stations on a revolving index table. Measuring 1 3/16 by 11/16 inch, it provides up to 6 supply ports from each intake connection. Intake is both threaded

New Production Capacity For Fast Delivery



Large Generated Gears

SPUR • HERRINGBONE • HELICAL

for a wide range of industrial applications

Gears which must operate smoothly and without vibration at higher speeds and under greater loads must correspondingly be more accurate in tooth profile and spacing.

H & S Generated Gears answer these demands.

Offering the same high-quality standards which characterize the complete H & S Gear line, production capacities for large generated Spur, Helical and Hobbed-Herringbone Gears are now available in the following dimensions:

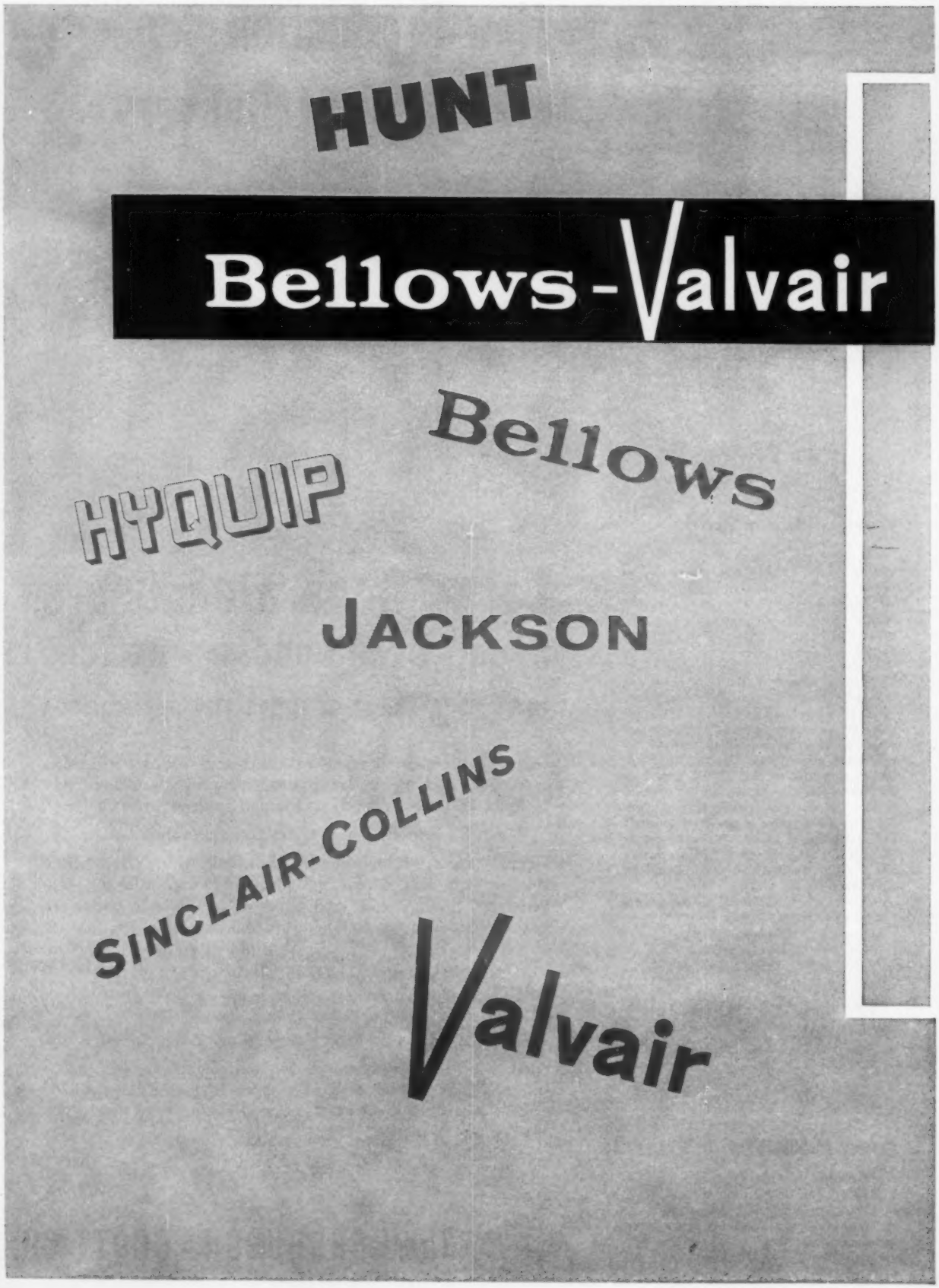
Up to 80″ outside diameter at 1 DP
Up to 90″ outside diameter at 1¼ DP
Up to 100″ outside diameter at 1½ DP
Up to 125″ outside diameter at 2 DP
Face widths up to 42″, depending on helix angle

Send your specifications, or let our technical staff make recommendations. H & S specializes in fast production of quality industrial Gearing and Speed Reducers to meet your custom requirements.

Write for Catalog FLB-60

The HORSBURGH & SCOTT CO.
5112 Hamilton Avenue • Cleveland 14, Ohio

Circle 704 on Reply Card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HYQUIP
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NOW...ONE SOURCE

for pneumatics·hydraulics and related electronics

These famous trade names — Bellows . . . Valvair . . . Hunt . . . Sinclair-Collins . . . Hyquip . . . Jackson — have many things in common. Two are outstanding. These companies are known to industry as leading suppliers of pneumatic, hydraulic and electronic products. And, they all are part of International Basic Economy Corporation (IBEC).

To make it easier for you to select the most economical combination of related products best suited to your needs . . . to provide you with application engineering recommendations for entire control systems . . . to render unmatched service . . . these sources of specialized products have been combined into one engineering, sales and service organization — Bellows-Valvair.

The Bellows-Valvair Pneumatics Division will engineer, sell and service all Bellows, Valvair and Hunt products involving the use of air. The Bellows-Valvair Hydraulics Division will engineer, sell and service Hunt, Sinclair-Collins and Hyquip hydraulic products, as well as Berry-Dowty gear pumps and motors. The Bellows-Valvair Electronics Division will engineer, sell and service all related electronic devices.

Consolidation of all sales and service under the name Bellows-Valvair combines the knowledge and experience of over 300 design, production and field engineers. The resources of this group are at your service, ready to aid you in the engineering and application of pneumatics, hydraulics and electronics, to solve your production problems.

1196-C

New Bulletin FP-62 will give you more information on the divisional product groupings. For your copy, contact the field office near you (listed in the Yellow Pages and Thomas' Register, Volume IV), or write to Bellows-Valvair, Akron 9, Ohio, Dept. AU-1161.

Bellows-Valvair

Division of IBEC AKRON 9, OHIO

These names assure you the best in pneumatic, hydraulic and electronic components

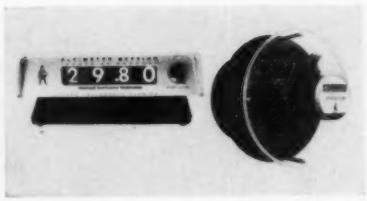
BELLOWS · VALVAIR · SINCLAIR-COLLINS · HUNT · HYQUIP · JACKSON ELECTRONICS

and tapped so that it may be used either as 1/8-inch NPT male thread, or 10-32 port. Output consists of 6 ports tapped 10-32 for a variety of hose or tubing fittings. Unused ports may be a plugged with screw plugs and gaskets. Air flow rate at 50 psi is 5.9 cfm. Recommended working range is up to 250 psi. **Clippard Instrument Laboratory Inc.**, 7390 Colerain Rd., Cincinnati 39, Ohio.

Circle 436 on Reply Card

Digital Converter

Designated Discon, digital scanner and converter, right side of picture, reads a wide variety of gages and meters without



physical connection or alteration to the shaft or pointer of the instrument itself. Applications include such devices as: Weigh scales, pressure gages, flowmeters, servo indicators, and synchro devices. Accuracy and resolution are up to one part in 10,000. Instrument dials from 3 to 20 inches in diameter can be accommodated. Operating photoelectrically, the scanner has a range of scanning rates that vary from 1 to 6000 per minute, or upon command only. Remote digital outputs, left side of picture, in many forms are offered. Unit features modular plug-in printed circuit boards and may be adjusted to any desired scale factor for direct solution of simple equations with one variable and conversion units and to totalize, average, or integrate readings. **MacLeod Instrument Corp.**, 4250 N.W. 10th Ave., Fort Lauderdale, Fla.

Circle 437 on Reply Card

HANSEN

SERIES HK® QUICK-CONNECTIVE

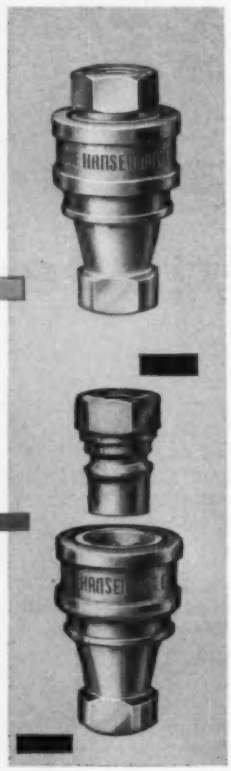
TWO-WAY SHUT-OFF COUPLINGS

QUICK FLUID LINE CONNECTION OR DISCONNECTION

WITH

INSTANT AUTOMATIC FLOW OR SHUT-OFF

Instantly shuts off both sides of line... prevents loss of liquid, gas or pressure



When Coupling is disconnected, identical valves in both the Socket and Plug provide instant shut-off of gas or liquid. To eliminate leakage or spillage during disconnection, the Coupling is so designed that shut-off takes place *before* the Plug separates from the Socket—and *before* the seal of the Socket itself, provided by the Socket "O" Ring, is broken.

In reverse, when Coupling is connected, the "O" Ring in the Socket completely seals Coupling *before* valves release flow of fluid from both sides of line—thus eliminating possibility of spurt of gas or liquid during instant of connection.

Available in brass or steel with female pipe thread connections from ⅛" to 1½" inclusive—also up to 1" in stainless steel.

Write for the Hansen Catalog

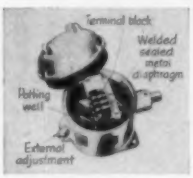
Here is an always ready reference when you want information on on couplings in a hurry. Lists complete range of sizes and types of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings —including Special Service Couplings for LP-Gas, Steam, Oxygen, Acetylene, etc.

Representatives in Principal Cities ... see Yellow Pages

SINCE 1915 QUICK-CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

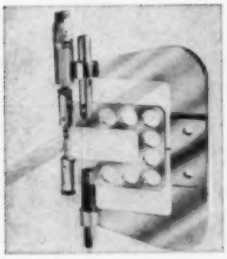
4031 WEST 150th STREET • CLEVELAND 35, OHIO



Pressure Switches

Explosion proof diaphragm pressure switches with set and reset accuracy of ±½ per cent can be adjusted externally without exposing the circuit. Housings are built with electric outlets that can be sealed with potting compound, and integral terminal blocks are provided for wiring convenience. Diaphragm capsules are removable without interfering with switch wiring and may be interchanged easily to accommodate varying pressure requirements or fluid characteristics. In the low setting the switches will actuate at 0.1-inch mercury with proof (test) pressure to 10 psi. In higher ranges they will go up to 300 psi proof (test) pressure at settings to 150 psi. Standard pressure connection is ¼-inch npt female pipe fitting. Single and dual control models are available. **Barksdale Valves**, 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle 438 on Reply Card



Floating Caliper Fixture

Remote indication, recording, or automatic control of thickness of steel, plate glass, fiber board, or similar strip material is accomplished with this Model 130 floating caliper fixture. Floating design allows independent movement of two gaging rollers to insure firm contact with both surfaces of the material at all times. Nominal thicknesses up to one inch can be measured with an accuracy to 0.001 inch. A deep throat allows measurements to be taken away from the edge of the strip. Work is contacted by precision ball bearing wheels with

NOW the only rotary indexing chassis with built-in lever pivot shafts

Provides more tool-driving capacity than anything in its field

The high cost of automation may not be as high as you think.

Not if you get your automation program's basic building block—an automatic transfer machine—from Sylvania.

For Sylvania automatic transfer machines cost less than machines which can meet their productivity and precision standards. And they're more precise and more productive than other machines in their price class.

FOR EXAMPLE

Our Heavy Duty Rotary Indexing Chassis is a case in point.

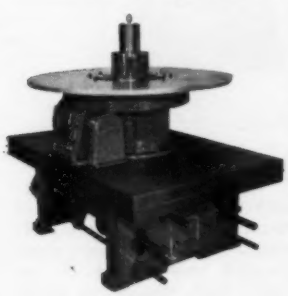
It's the *only* rotary transfer machine on the market with lever pivot shafts built in.

This makes it far easier to synchronize or time your automated operations, far less expensive, too.

What's more, with two full-length 1⅝" diameter camshafts keywayed throughout and supported by heavy-duty sealed ball bearings, we think this Sylvania machine provides more tool-driving capacity than any machine of similar quality and price.

THINKING ABOUT AUTOMATING?

If you are, you probably know that every automation program must start with a transfer machine. If it's a good one, you'll be off to a good start. If it's not, you're defeating your purpose because your program will probably never be satisfactory.



Sylvania makes several different kinds of transfer machines. By changing the tooling, they can be adapted to any conceivable production operation. You can change products without changing transfer machines.

We'll provide you with free consultation to help get your automation program started—even recommend experienced designers and manufacturers of tooling if you don't have the facilities to do the job.

Since a good transfer machine will last 30 years or more, it pays to get the best. We think ours are, because we've never been able to find one that will meet our accuracy standards for the manufacture of lamps, tubes and fine electronics equipment. That's why we build our own.

We'll be glad to send one of our automation sales engineers to consult with you on your automation program and needs. If you'd like more details on the transfer machines we build, send for our free brochure. Naturally, there's no obligation.

SYLVANIA LIGHTING PRODUCTS
Equipment Development Plant
121 Loring Avenue, Salem, Mass.

Please send me free brochure of:

☐ Rotary ☐ 44-Station Conveyor and 90-Station Conveyor ☐ Transmissions

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GENERAL SYSTEM

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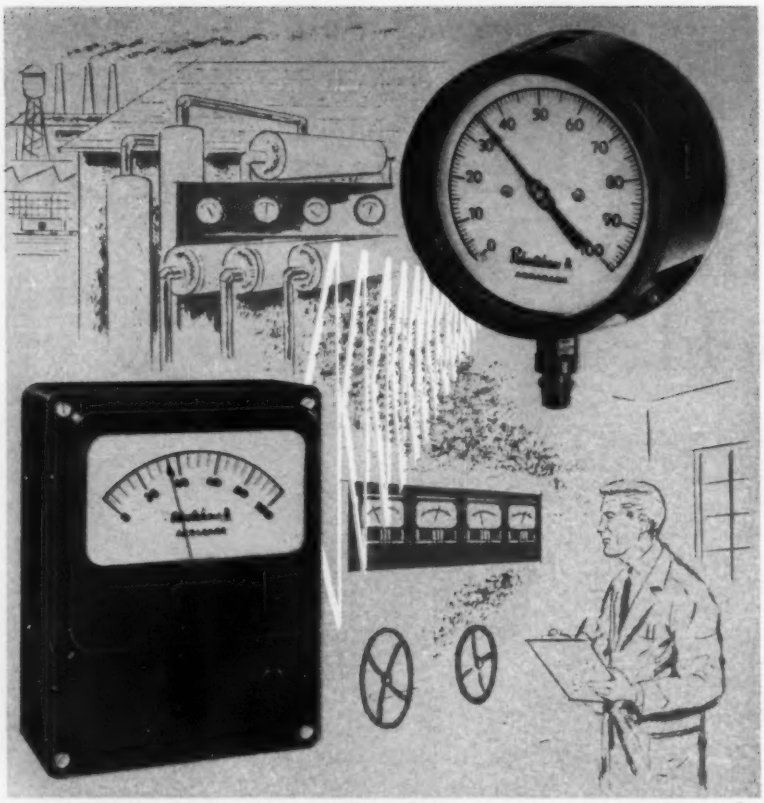


ACRAGAGE®

Electric Transmission System Gives Instant Reading of Remote Pressures

From remote process points at any reasonable distance, Acragage Electric Transmitters signal pressure changes to your central control panel for immediate reading and necessary action.

Now in full production at Robertshaw's Knoxville plant, this trouble-free transmission system is available for fast delivery . . . and quick, efficient solution to your remote pressure-reading problems.

Rotary type potentiometer in transmitter assures accuracy to ±1%, with instantaneous response. Large, easy-read dials on transmitters and receivers; available for flush or wall mounting.

Full specifications and ranges in new folder VK-763.

Robertshaw®
HR. CONTROLS
Robertshaw-Fulton Controls Company

FULTON SYLPHON DIVISION • KNOXVILLE 1, TENNESSEE

Circle 708 on Reply Card

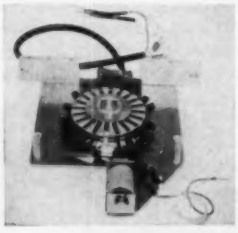
only such force as is necessary to maintain firm contact. The device incorporates a differential transformer transducer which transmits measured values to a variety of available instrumentation items for the desired type of readout function. **Daytronic Corp.**, 225 S. Jefferson St., Dayton 2, Ohio.

Circle 439 on Reply Card

Latch-In Fault Indicator

Three-quarter-inch, sealed miniature magnetic latch-in fault indicator is available in wide current and voltage ranges to provide flexibility in meeting circuit requirements. Operation is as follows: A disc-type flag, which may be color coded or imprinted to designate the function being monitored, rotates behind a sector window. When de-energized, the flag is magnetically held in the *Off* position. When energized, it rotates to the *On* position and is held there magnetically even if the energizing source is removed. Return to the normal *Off* position is accomplished by reversing the polarity of the energizing source. This device maintains positive indication even when de-energized under vibration from 10 to 500 cycles at 10 g. **Precision Meter Div., Minneapolis-Honeywell Regulator Co.**, Grenier Field, Manchester, N. H.

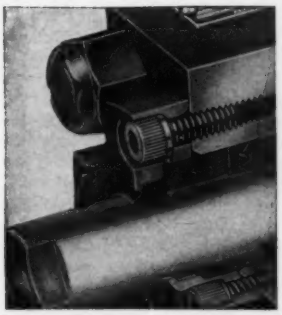
Circle 440 on Reply Card



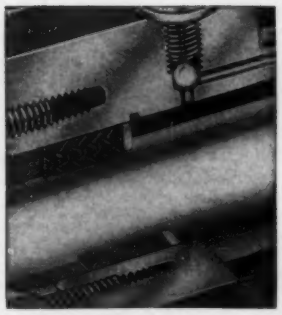
Binary Memory Switch

This switch is built upon principle of a rotary element or module having *X*-positions which are geared to and corresponding to each operation on an operational cycle. Each module can record one bit of information on each position. Thus, a single-deck switch, illustrated, may record 20, 40, or 60 bits of information on one revolution, depending on the number of steps provided. If several operations are to be recorded simultaneously, several decks can be provided on the same shaft. Actual recording is of a simple type. Two input solenoids operate a small trigger which is moved to one side for *Yes* or *Go* and to the other side for *No* or *No-Go*. The center position may be used to show fault. A switch without the center position is also made where simple computations are actually made on the

Do the cylinders you buy include these quality features?

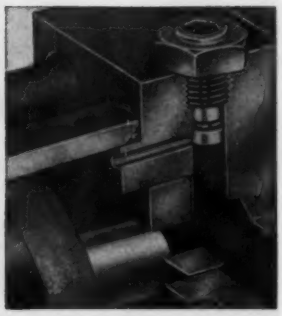


ROD GLAND—Easily removed. No need to loosen tie rods. Cuts maintenance time in half. Phenolic bearing insert will not score rod. Cuts replacement cost to a minimum.

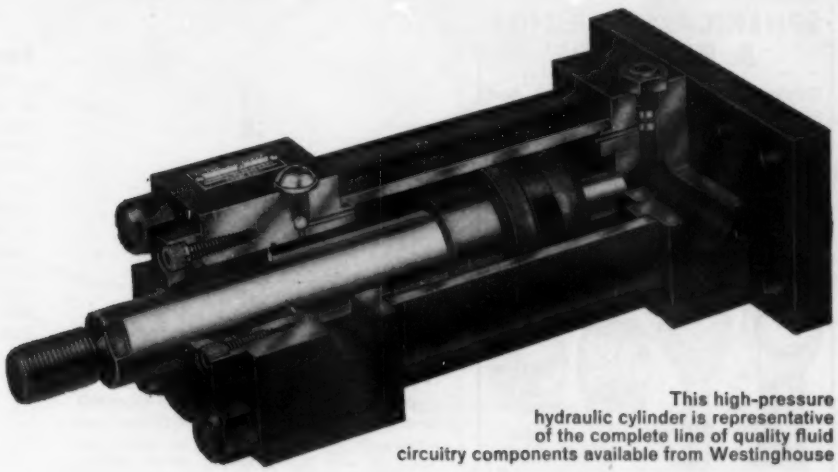


ROD PACKING—Interlocking multiple lip seals require no adjustments; remain flexible under fluid pressure. Wear compensating function eliminates frequent replacement.

PISTON—Phenolic piston will not score tube. Packing cups used for proven long life and seal. Cups are easily replaced. Piston positively locked to rod.



CUSHION—Minimum clearance between piston and Meehanite Bushing combined with micrometer metering give stop cushioning efficiency and a wide adjusting range.



This high-pressure hydraulic cylinder is representative of the complete line of quality fluid circuitry components available from Westinghouse

if not, the chances are, your maintenance costs are higher than necessary. For more information about Quality Fluid Circuitry Controls for trouble-free automation, ask for Catalog A3-56.00.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.

WESTINGHOUSE AIR BRAKE COMPANY

INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

Circle 709 on Reply Card

Features that set them apart from whatever is "second-best"!

Cutaway view of TRE Male Rod End.

SPHERCO®

SPHERICAL BEARINGS & ROD ENDS

Quality SPHERCO Bearings and Rod Ends are precision built for superior performance. They are available in a wide range of sizes of varying design and materials to meet specific requirements. A SPHERCO engineer in your area will be happy to help you with your problems.

WRITE FOR CATALOG 560

SPHERCO

A PRODUCT OF SEALMASTER BEARING DIVISION STEPHENS-ADAMSON MFG. CO.

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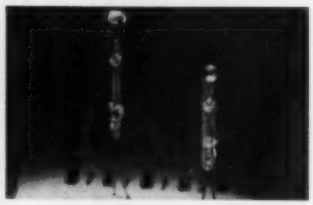
Circle 710 on Reply Card

switch, thus reducing the necessary equipment. **Tech Laboratories Inc.**, Bergen & Edsall Blvds., Palisades Park, N. J.

Circle 441 on Reply Card



Silicon Photosensors

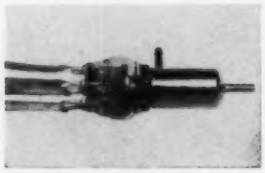
Line of silicon photosensors with high voltage capabilities make possible greater economies in the design of photo diode readout circuits for data processing equipment. Capable of handling up to 20 volts of reverse breakdown voltage with under 10 microamp of leakage current, these photosensors are designed as readout devices for circuits that convert light information into usable electrical signals such as pulses and sinusoidal waves. Although designed primarily for punched card and tape readout systems, other applications include teletypewriter coding, production flaw testing, signal switching, photographic sensing and control, optical scanning, and sound pickup. Spectral response covers the range from visible to near infrared radiation, from 5000 angstroms to 11,000 angstroms. Peak response is at 9500 angstroms. **Lansdale Div., Philco Corp.**, Lansdale, Pa.

Circle 442 on Reply Card

Transfer Pump

Air-powered transfer pump is designed to eliminate hand pumping of fluids from drums to other containers or points of use. It will pump up to seven gallons a minute free flow, and handles fluids up to 90 weight gear oil easily. The pump will transfer almost any kind of noncorrosive fluid, including oils, gear oils, water, kerosene, gasoline, antifreeze, thinners, and solvents. Delivery is instantly adjustable from zero to full flow and operation is without hazard from explosion or sparks because the pump is completely air powered, requiring as little as 15 psi or on standard line pressures up to 150 psi. This pump can be adapted to any size or shape of open container from a hand pail to deep tank. **Industrial Div., Aro Equipment Corp.**, Bryan, Ohio.

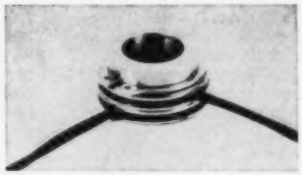
Circle 443 on Reply Card



Power Amplifier Triode

Three-element power amplifier and oscillator tube is designed for induction and dielectric heating jobs that require relatively high kilowatt output at a minimum of investment, or where it is desired to use low-voltage power supplies. The tube, designated Type WL 7255, is also suitable for use as a building block to increase the output of 5, 10, and 15-kilowatt r-f generators by adding tubes in parallel. Tube has flying leads for easier mounting and for minimizing strain in glass near the tube connection. Other applications include service in linear Class B amplifiers of sonar and ultrasonic systems. Tube permits generation of 6 kilowatts at a plate voltage of 5 kilovolts and 13½ kilowatts at a plate voltage of 9 kilovolts. **Electronic Tube Div., Westinghouse Electric Corp.**, P. O. Box 284, Elmira, N. Y.

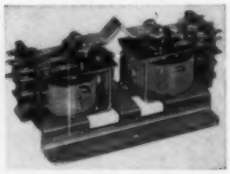
Circle 444 on Reply Card



Force Washer

Temperature compensated force washer is available in standard bolt sizes ranging from 3/16 to 1 inch in diameter. The loads for these diameters may range from 5000 to 35,000 lb, depending on bolt diameter selected. Temperature compensation is better than 0.5 microinch/in./ degree F over a range of 50 to 250F. Accuracies of better than ±1 per cent of full scale sensitivity are held for linearity, repeatability, and hysteresis. **Avionics & Industrial Products Div., Lockheed Electronics Co.**, 6201 E. Randolph St., Los Angeles 22, Calif.

Circle 445 on Reply Card

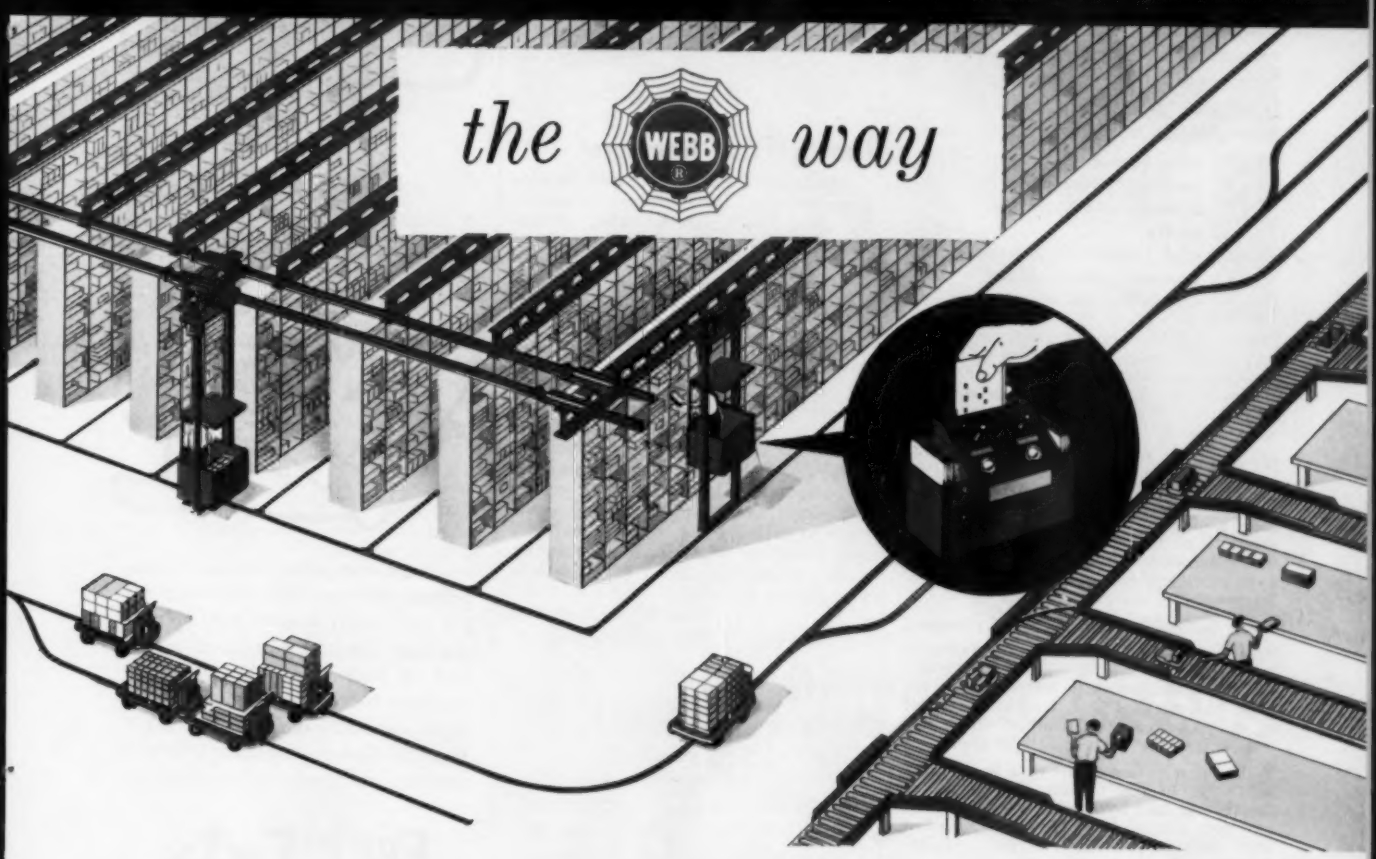


Latching Relays

Type LFA (5 amp contact rating) and LFB (10 amp contact rating) electrical latch, electrical reset latching relays are available in a variety of ac and dc coil voltages. Simple latching mechanisms used in the relay have only two moving parts. SPDT (1C), DPDT (2C) and 3PDT (3C) contact arrangements make it adaptable to many control and overload ap-

automatic warehousing...

the WEBB *way*



It takes various types of materials handling equipment to make a warehouse completely automatic. And it takes a specialist for each type of equipment to recommend the perfect system.

Some companies are specialists in stacker cranes, others in automatic tow lines, still others in roller dispatching conveyors. A lot of specialists . . . a little responsibility for each.

The Jervis B. Webb Company Divisions manufacture a complete line of materials conveyance . . . all kinds of cranes and monorail systems, all kinds of conveyors, all kinds of controls. There can be many solutions that will comprise a good installation, but THERE IS ONLY ONE BEST WAY.

Through Webb versatility, we can analyze your warehousing problem and recommend the *perfect* system, taking complete responsibility . . . THAT'S THE WEBB WAY.

WEBB

JERVIS B. WEBB COMPANY

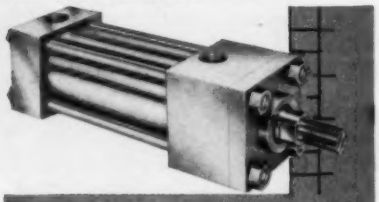
8951 ALPINE AVENUE • DETROIT 4, MICHIGAN

Send for our free four-page brochure on Automatic Warehousing

Circle 711 on Reply Card

NEW O-M SQUARE-HEAD AIR AND HYDRAULIC CYLINDERS

GIVE THE PERFORMANCE YOU EXPECT... AND MORE



Air—(rated 200 psi)
Hydraulic—(rated up to 2000 psi)
Meet JIC Standards 1 ½" to 14" Bores

Long Service
Uniform Performance
Dimensional Interchangeability
High Operational Efficiency
Compact — Saves Space
Quick, Easy Maintenance

Made of the highest quality materials and seals, these new components combine modern design, the latest and best engineering advancements with O-M specialized "know how" and precision workmanship.

New Series "K" Air Cylinders

Construction features include brass cylinder barrel, chrome-plated, high tensile steel piston rod with a minimum yield strength of 90,000 to 100,000 psi. Rolled and machined steel heads and extra long cartridge-type rod bearing assure perfect alignment of piston rod.

New Series "L" Hydraulic Cylinders

Similar in many construction features to Series "K", but specifically designed for hydraulic service. Incorporate vee-type rod packing and a cylinder barrel of micro-honed steel tubing which are best suited for hydraulic operations.

With the addition of the new Series "K" and "L" to the Ortman-Miller major line of air and hydraulic cylinders, you can now rely on O-M for *all* of your low and medium pressure cylinder requirements.

Mail coupon today for complete details. All cylinders in Bulletins 115A and 116 have been dimensioned in accordance with NFPA recommendations for your convenience.

ORTMAN-MILLER MACHINE COMPANY
25 143rd Street, Hammond, Indiana

☐ Have representative call
Please send Bulletin(s)

☐ 115A—Series "K" ☐ 116—Series "L"

NAME_____

POSITION_____

COMPANY_____

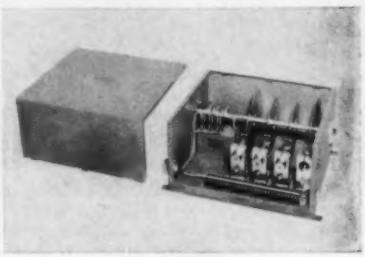
ADDRESS_____

CITY_____ ZONE___ STATE_____

Circle 712 on Reply Card

plications. Nominal operating power is 2 to 3 watts for dc and 3 to 4 voltamperes for ac. Mechanical life expectancy is 500,000 operations. Temperature range, when specified, is −55C to +85C. **Electronics Div., Elgin National Watch Co.,** 2435 N. Naomi St., Burbank, Calif.

Circle 446 on Reply Card



Cam-Operated Transducer

Adjustable cam-operated transducer supplies continuous signal between reciprocating press, loader, and unloader. Amplification is achieved with the use of large cadmium plated cams which provide appreciable changes in transducer output signal for very small changes in rotary motion. Photograph illustrates this principle as applied to linear variable differential transformers. Additional auxiliary control sequencing is furnished by standard split lobe adjustable cams operating snap action limit switches. Other uses include transducer applications incorporating potentiometers, synchros, revolvers, selsyns, hydraulic servos, etc. In each case, the input positioning signal may be either linear with a gear and rack pickoff or rotary for direct coupling. **Gemco Electric Co.,** 25685 W. Eight Mile Rd., Detroit 40, Mich.

Circle 447 on Reply Card

Valve Actuators

Several variations of this electrohydraulic Hydramotor valve actuator line have been developed to meet specific requirements of steam-electric power generating plants, fuel valves on pipeline compressor engines, unloading valves on pumps, compressors, and other applications. The control circuit variations allow an actuator to hold its last position in event of main power failure. The actuator then responds to a secondary or emergency power source when such response is required. All actuators consist of an electric motor driven pump, a spring loaded hydraulic cylinder, and electro-

B-I-F POSITIVE CONTROL OF MATERIALS FLOW

Need completely slaked, homogeneous mixtures? Do shut-downs for grit and clinker removal hold up production? Do hot, dust-laden vapors foul up your feeder? Do you have excessive bearing trouble . . . causing leaks and costly maintenance? B-I-F Pug Mill Slakers save lime, time and trouble...add profits to your process!

Free Facts

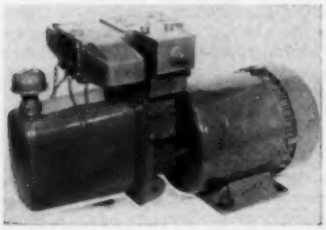
For automatic, unattended operation . . . for progressive zone slaking . . . for positive water ratio control at all rates, ask for details on the most advanced, performance - proved slaker available. Write for free facts today!

B-I-F Industries
A DIVISION OF THE NEW YORK AIR BRAKE COMPANY
527 HARRIS AVENUE, PROVIDENCE 1, RHODE ISLAND

Circle 713 on Reply Card

magnetic relief valve. They provide adjustable opening speed, 10 to 60 seconds, and spring-return closing within one second when tripped for emergency shutoff. Up to 12 auxiliary switch contacts can be set independently to operate at any point of valve travel for positive interlock sequencing of other system components. Industrial Controls Div., General Controls Co., 801 Allen Ave., Glendale 1, Calif.

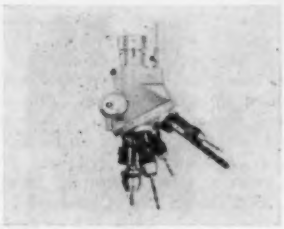
Circle 448 on Reply Card



Hydraulic Power Packages

Motorized hydraulic power packages incorporate pump, motor, valving, and reservoir in one compact assembly. The pump is mounted directly on the electric motor's extended shaft, contributing to dependability and ease of installation. The units, with a maximum pressure rating of 1500 psi, are available in three series. Series PKS1, with outputs to 8 gpm, comes with one or two solenoid valves and an overload relief valve. Series PKM1, with outputs to 8 gpm, is offered with up to three manually operated valves and a non-adjustable overload relief valve. Series PKM6 basic models without control valves have outputs to 5 gpm. An adjustable overload relief valve is included. Electric motors are available in five sizes from 1 to 5 hp at 1800 rpm. Vickers Inc., Div., Sperry Rand Corp., Detroit 32, Mich.

Circle 449 on Reply Card



Multispindle Drill Head

Model ARBO-3 multispindle drill head takes 2 to 5 tools at one time. All spindles are completely and quickly interchangeable. Eight speeds are available. All work spindles are provided with suitable Morse and Jacobs tapers, and with suitable drilling and tapping chucks. Special tapers may also be obtained. Workpieces are completely machined with single setup. No reversing of the drill spindle is necessary during tapping operation. Drill head capacities: Drilling, ⅛ to 1 inch; tapping, ⅛ to 15/16 inch. Jersey Mfg. Co., 401 Livingston St., Elizabeth, N. J.

Circle 450 on Reply Card

Solid State Annunciators

Feature of this line of miniaturized annunciators is their unique construction. Each annunciator circuit, including the lamps and light box, is contained in a single, channel-mounted module which is plugged into cabinets having either standard 2 by 3-inch nameplates (Model 361) or miniature ¾ by 1½-inch nameplates (Model 360 illustrated). All electronic components are mounted on etched circuit boards. The annunciators may be operated by either N.O. or N.C. field contacts by varying the external connections. Two operational sequences are available, either automatic reset or manual reset to normal after acknowledgement of an alarm. The annunciators may be operated from either ac or dc power sources, the regulated dc voltage required being obtained by means of a power converter. Nameplates are available in various colors along with a choice of audible signalling devices and acknowledge, reset, and test

SIMPLIFYING THE COMPLEX Minivac® 601

Reducing the complexity, removing the esotericism without loss of sophistication or basic concept, the MINIVAC 601 can perform all the basic operations of large computers. It can learn, remember, calculate, solve logical problems and make decisions. But most important, it illustrates how these same functions are performed by complex computer systems.

Developed as a private project by Dr. Claude E. Shannon, now Donner Professor of Science at the Massachusetts Institute of Technology, MINIVAC simulates computer applications in business, science, politics, and the military. It demonstrates how computers read printed material, provide automatic control, and duplicate many attributes of intelligent behavior. It can recognize geometric forms, solve simple mazes, perform mathematical operations, and translate languages.

No previous knowledge of mathematics or electronics is needed to use MINIVAC. Six comprehensive manuals accompanying the computer guide the user in his exploration of digital computers, their application, potential and limitations.

$85.00

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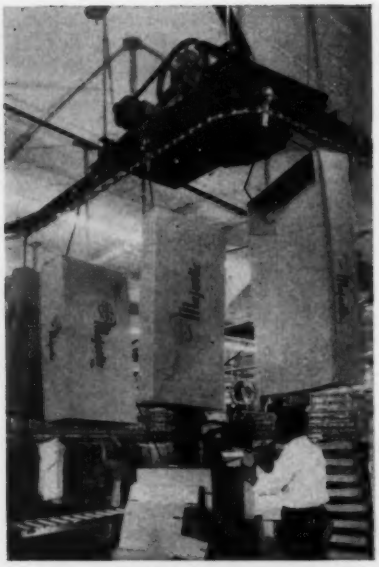


AERIAL CARTON STORAGE GIVES PROFITS A LIFT

Any manufacturing or warehouse operation that uses multiple packing stations or many kinds and sizes of cartons can profit from handling empty cartons on Rapistan overhead trolley conveyor. Present users are enjoying these benefits:

1. Automatic delivery of assembled cartons to point of use reduces handling labor.
2. Less floor space required for each packing station.
3. Mobile storage of made-up cartons off the floor.
4. Central stitching or stapling area for carton set-up close to knocked-down carton storage.
5. Removal of containers from unload areas.
6. Recirculation of tote boxes or other containers.

With a Rapistan system, one manufacturer gained a 10′ x 15′ office and space for 9,000 inventory items where empty cartons used to be stored—and reduced carton handling costs at the same time.

For other examples of money-saving overhead systems for handling empty containers, write Rapistan-Keystone, Inc., 558 Rapistan Bldg., Grand Rapids 2, Mich. Ask for report No. RK-13.

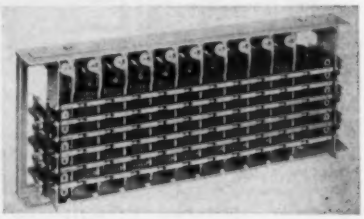
Rapistan®

OVERHEAD CONVEYORS

Circle 715 on Reply Card

switches. **Instrument Div., Thomas A. Edison Industries, McGraw-Edison Co.,** 61 Alden St., West Orange, N. J.

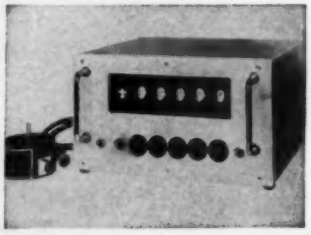
Circle 451 on Reply Card



Crossbar Switch

Switch includes five Form C gold contacts per crosspoint and up to 120 crosspoints. Within each hold group the makes and breaks each have common contact strips for the 12 crosspoints. Dielectric strength is limited to 750 vac and 1000 vdc. Insulation resistance is greater than 10^5 megohms at 25C with 40 to 50 per cent R.H. Applications for the switch include use in automatic test equipment designed to check cables or components, analog and digital computer functions, programming and sequencing, and high traffic communications. **Electronetics Div., North Electric Co.,** Galion, Ohio.

Circle 452 on Reply Card



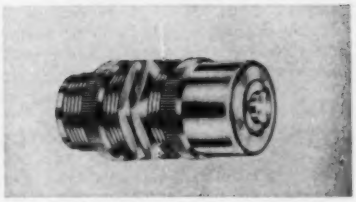
Bidirectional Counter

Transistorized, compact, bidirectional counter indicates true position while going through zero in either direction. This capability eliminates the need for external reset to establish a reference. One of the many uses of the counter, in conjunction with a Phototron analog-to-digital converter, is for "target scoring" tests of precision potentiometers, synchros, or other electromechanical transducers. Another application is in the field of flow measurement and control. The counter allows true readout of differential flow by adapting the analog-to-digital converter to operation as a flowmeter. **Hydro-Aire Div., Crane Co.,** 300 Winona Blvd., Burbank, Calif.

Circle 453 on Reply Card

Electromagnetic Transducer

Dual-purpose transducer, designated Type PR-9262 can either detect or excite vibrations without contacting the object to be tested. It can be used in cases where the object to be measured has so small



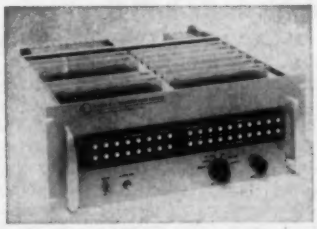
a mass that any contact with an indicating instrument would influence the vibration. Device also permits investigation of pulsating phenomena. A feature of this unit is the absence of any contact resonance. The object to be measured, or vibrated, need not be magnetically conductive. By affixing a thin disc of silicon steel to an object, it is rendered effective for study by the pickup. This light-weight transducer will measure both relative and absolute vibrations, transforming the vibrations into electrical voltages whose magnitude is proportional to velocity. By using the proper integration network, the pickup will also read amplitude and acceleration of vibrations. **Acoustics & Instruments Div., Korfund Co. Inc.,** 40S Cantiague Rd., Westbury, L. I., N. Y.

Circle 454 on Reply Card

Time Delay Control

Especially ideal for applications in magnetic amplifier circuits, this time delay control is also suitable for employment in conjunction with flip-flop gating circuits such as are used in electronic computers and analyzers, missile controls, and other applications subject to wide and varying changes in temperature. In effect, the control develops pure dc voltage from signals of any wave length applied to it. It operates automatically and eliminates many of the components ordinarily required by similar devices. Outstanding control feature is that it is independent of ambient temperatures up to 350 F. It is also unaffected by external radiation and random noise. **Victoreen Instrument Co.,** 5806 Hough Ave., Cleveland 3, Ohio.

Circle 455 on Reply Card



Magnetic Core Memories

Series of magnetic core memories, designated EECO 8-level, has been developed for use in the design of data conversion

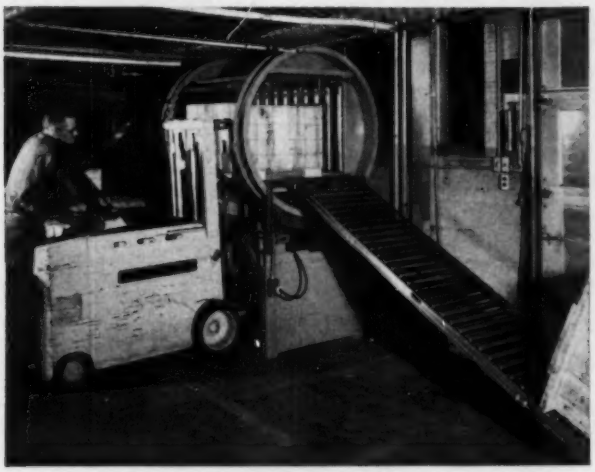
RAPISTAN Ideas HANDLING

HOW "TECHNICS" PLANNING PAYS "COMPOUND SAVINGS"

In any business, whether yours is a manufacturing plant, a wholesale warehouse, a retail or chain operation, or a service industry, materials handling is the one function that is closely related to all the other management arts.

Because of its influence on so many other departments and functions, it can be utilized as a management tool, to coordinate methods improvements throughout an organization, directed toward the common goal of reduced operating costs and increased profits.

This principle is the basis of Rapistan's proven "Technics" approach to cost reduction. It starts with the materials handling system, in all its aspects; then, extends the benefits of improved materials flow to produce subsidiary benefits in other areas of management as well.



New containerization of these conveyor wheels, specified by Purchasing, coupled with a new automatic unloading device designed by Plant Engineering, speeded truck unloading to 1/12th the former time. Wire-bound crates are designed for re-use as finished goods shipping containers for a further saving.

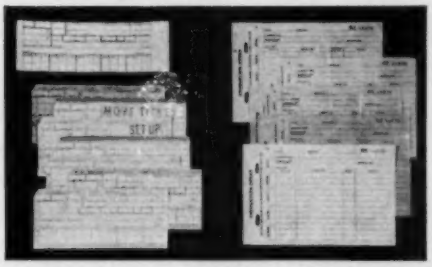
Thorough Planning—The Key

Rapistan's "Technics" concept of materials handling goes an important step beyond solving the problems of movement, transfer, storage and flow control. It recognizes the inter-relationships of the flow system with other management functions—purchasing, industrial engineering, product design, manufacturing, quality control—even clerical procedures.

By thorough planning, to augment and capitalize on improvements in the flow system through all related management activities, a "Technics" plan gives management maximum return on its investment.

A successful Technics program requires skillful coordination, under centralized and authoritative direction. Only top management can provide this. But, by the nature of his specialization, the materials handling engineer can contribute much to such a program. Your Rapistan sales engineer can offer new ideas and techniques of materials handling. And, his knowledge of "Technics" principles can help you compound the savings in many related phases of your total operation.

Plant engineers who designed this transfer mechanism to match Rapistan live storage Flow Racks helped make the entire system more efficient and versatile. Such contributions illustrate relationship between plant functions and materials handling, developed through Technics planning.



IBM data processing is coordinated with the flow system in this successful Technics program. These cards trigger movement of raw materials and work in process into and out of storage, and over the conveyor system between manufacturing operations.

This new brochure illustrates "Technics" planning at work in the management of materials, solving problems of inventory control, order selection and similar warehousing functions for manufacturing and distributing firms. For your copy write to The RAPIDS-STANDARD CO., Inc., 557 Rapistan Bldg., Grand Rapids 2, Michigan.

Rapistan®
CONVEYING EQUIPMENT

Compare Index Units! FERGUSON "PROVES OUT" . . . Point by Point.

Selection of components for a production machine should be based upon the machine's return per dollar investment. Matching "first costs" only does not generally result in the design of profitably operated equipment.

Here is a check list for comparison of indexing mechanisms. "Price" is shown in its order of consideration.

1. BACKLASH—None? Some during the dwell or index or both? *Any* backlash during *any* part of the cycle results in wear-causing vibrations and shock loads . . . *The Ferguson Drive maintains zero backlash at all times.*

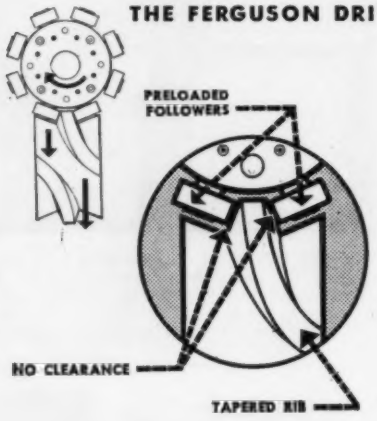
2. RATED LOADS—What is the rated life and under what load? What is the average follower life (B-10 life)? The Ferguson Drive is rated at maximum precision for at least 8,000 hours operation and with an average follower life of 90%. Replacement of the followers renews the life of the Drive for another 8,000 hours. Ferguson cams never wear out under rated loads.

3. JOB SUITABILITY—Can the acceleration characteristic be preselected according to job requirements or is it inherent in the mechanism or limited by the manufacturer? Acceleration of the Ferguson Drive can be chosen after an application evaluation to provide optimum operation.

4. INDEXING ACCURACY—Are time-consuming shot pins necessary for precision? . . . They soon wear and lose accuracy. The Ferguson Drive is positive locking and locating for extreme precision without shot pins.

5. FIRST COST vs. TOTAL COST—Now consider the higher production rates, better quality and much lower maintenance costs the Ferguson Drive gives you. Determine the *total cost* of the various indexing mechanisms. The Ferguson Drive has proved out . . . And you're on the way to building more profitable production equipment.

THE FERGUSON DRIVE



Cam features a tapered rib along which two standard cylindrical followers roll without clearance . . . *maintaining zero backlash during index and dwell.* While in the dwell or "work" position a straight portion of the cam rib locks the hub positively, without auxiliary locating or locking devices. *Extreme precision is inherent,* even at speeds as high as 2,000 indexes a minute!

CATALOG NO. 161 gives complete design data on nearly 100 standard indexing mechanisms, over 150 index tables and various auxiliary items. Send for your free copy . . . There's one for every design engineer.

ferguson

FERGUSON MACHINE COMPANY

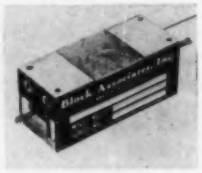
A Division of Universal Match Corporation

7818 Maplewood Court • St. Louis 17, Missouri

Circle 717 on Reply Card

and data processing systems. They have a capacity of 128 to 2048 characters and are available in three different models; random access, sequential access, and sequential interlace. Speed of these devices is 200 kc or 5 micro-seconds between load and unload commands. Readout is nondestructive, and data remains in the memory until new data is loaded or an erase signal is received. An erase signal will clear the entire memory. Separate front panel indicators display each bit in input register, output register, load address, and unload address. **Electronic Engineering Co. of California,** Sales Dept., 1601 E. Chestnut Ave., Santa Ana, Calif.

Circle 456 on Reply Card



Linear Actuator

Model BM-02 high force linear actuator is a special type of biased moving iron transducer where the moving element is displaced perpendicularly to the magnetic lines of force. This permits a linear relation between force and both current and displacement. Main advantage of the unit is a push-pull actuation with a force larger than that of comparable solenoids and a speed response many times faster. Applications of this switch include: Linear motions formerly obtained with a motor and an eccentric, vibration sorting equipment, shaking tables, and high speed printing. Specifications: Force, 3 lb; time constant, 5 milliseconds; stroke displacement, 5/16 inch; maximum rated (linear range) stroke displacement, ¼ inch. **Block Associates,** 385 Putnam Ave., Cambridge, Mass.

Circle 457 on Reply Card

Digital Sensing Devices

Line of digital Rotopulser sensing devices for precise industrial measurement and automation control converts mechanical motion into digital voltage pulses. These pulses provide numerical readout of the measurement and actuation of any desired control function in either batching or continuous process operations. Devices are available in two basic designs (zero speed and magnetic type) which provide required accuracy and transfer information over any distance without error or drift. They are designed for use with present counters, controllers, tachometers, totalizers, rate indicators, and

This is the Colossal Collator and Binder, a marvel of early day automation and a tonic for hard-cover book sales circa 334,567 B.C.

GREAT MACHINES OF WESTERN MAN

This backward look at the backward days of automation is lovingly dedicated to industry everywhere by Barkley and Dexter with this reminder: that industry anywhere can progress and profit from the forward looking services of B & D, one of the nation's foremost specialists in industrial mechanization and automation.

You should know more about B & D. Here is what our service consists of:

PLANNING — we determine if mechanization can help you; where it can help you; how it can help you; how much it is likely to cost; how much it will save.

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TROUBLE SHOOTING — our long experience can help you eliminate bugs from your own production lines.

For further information, send for the folder on our services. Or better still, write us about your problem.

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50 FRANKFORT STREET, FITCHBURG, MASSACHUSETTS — PIONEERS IN AUTOMATION

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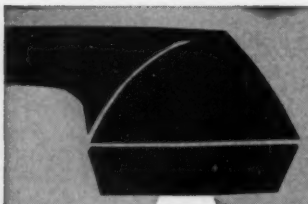
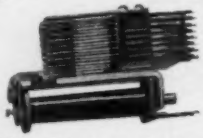


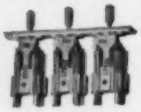
WHEN QUALITY IS A MUST

Stromberg-Carlson®

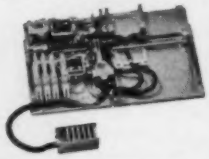
TELEPHONE-TYPE COMPONENTS



RELAYS: Wide range, for electro-mechanical switching. Send for Bulletin T-5000R2.



KEYS: Cam-type and push-button. Send for Bulletin T-5002R.



STEPPING SWITCHES. Fast and dependable. Bulletin T-5001R.

JACKS & PLUGS: For many electrical and electronic uses. Send for Bulletin T-5003.

TELEPHONE HANDSETS: Standard or with switch assemblies. Send for Bulletin T-5017-R.

For bulletins and more information contact the nearest Sales Branch office: Atlanta—750 Ponce de Leon Place N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Avenue; San Francisco—1805 Rollins Road.

GENERAL DYNAMICS TELECOMMUNICATION

Circle 719 on Reply Card

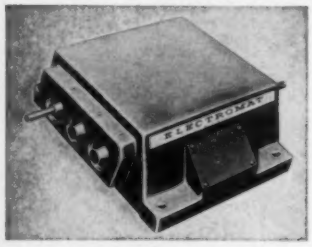
many other readout and control devices. Louis Allis Co., Dept. P, 427 E. Stewart St., Milwaukee 1, Wis.

Circle 458 on Reply Card

Time Totalizer

Small, inexpensive, nonresettable unit can be used to accumulate up to 1000 hours of operation of machinery or devices which require metering of time-in-use. The Time Totalizer is a mercury coulometer, operated by an integral electrical network which compensates for temperature and supply voltage variations. Two basic models are available for either ac or dc operations. Unit is assembled in a clear plastic housing which measures 1 by 9/16 by 2 3/16 inches and is hermetically sealed. Present models do not provide for circuit control. Leland Airborne Products Div., American Machine & Foundry Co., 261 Madison Ave., New York 16, N. Y.

Circle 459 on Reply Card



Electric Gear Transmission

Two-speed electric gear transmission for accurate machine positioning incorporates two electric clutches and an electric brake which are built into a precision gear transmission to provide a high-speed rapid traverse, low speed positioning, and consistently accurate stopping. Designated the Electromat Mark I, it provides remotely controlled speed selection, torque control, and braking action which can easily be integrated into any machine control system. Transmission is available in horsepowers ranging from 1 to 40 and speed ranges from 1:1 to 27:1. Other special designs are available. Electromatic Inc., 4169 Pearl Rd., Cleveland 9, Ohio.

Circle 460 on Reply Card

Liquid Level Transmitter

Device combines accuracy of mechanical measuring and efficiency of electronic signalling. It transmits dc signals proportional to level variations and is readily adaptable to many systems using electronic indicators, recorders, or controllers. Feature of the instrument is a LVTD displacement transducer coupled with an amplifer with solid state circuitry. High feedback maintains extreme accuracy and

AIR-HYDRAULICS INCORPORATED

NEW TABLE

HANDLES UP TO **ONE TON**

Index 30 positions per minute when equipped for 6 station operation with Air-Hydraulics' new Model 2400 (24" dia.) air index table • Handles work loads up to one ton • Bolt larger diameter plates to 1¼" ground steel table top for greater table area • Repetitive shock loads are no strain • 4" bore index cylinder develops power stroke 13 times line pressure for extra power and speed—no override • Adjustable cushion and speed control • Locking cylinder, mounted on table's centerline, means positive index every time— =.0015" • Limit switch keeps basic equipment from moving until table is "locked in" • Pressure lubrication, tapered roller bearing on shaft and ample bearing surface at circumference assure friction free operation • Operates on 60 to 175 psi line pressure • 4, 6, 8 or 12 stations with clockwise rotation standard • Others, including counterclockwise rotation, and from 3 to 60 positions to order.

WRITE NOW FOR CATALOG AND PRICE INFORMATION

AIR-HYDRAULICS INCORPORATED

A NEW PRESS FOR LESS

15 TON—AIR HYDRAULIC

• *Durable* • *Lightweight*

• *Compact*

Model C-500. A versatile press with 8¼ inch throat. 6 inch stroke, 2 inch adjustment, equalized pressure full length whether feather-touch or full blow. 100 pound air line gets up to 21 tons delivery. Stand or bench installation. Moving parts protected in handsome housing. Adjustable speeds. Hand, foot or automatic controls. Simple, tireless and safe operation. Women like it. Long, trouble-free service. Easy to maintain and repair. For all kinds of materials. Thickness no problem. Rivets, flanges, broaches, stakes, crimps. Many other uses.

WRITE TODAY FOR INFORMATION REGARDING APPLICATION TO YOUR JOB . . . AND HOW LITTLE IT WILL COST YOU.

AIR-HYDRAULICS INCORPORATED

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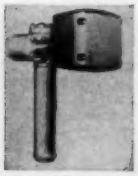
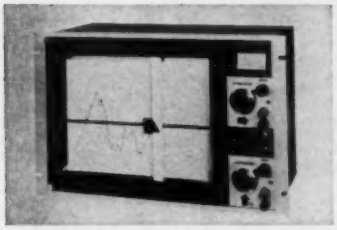


stability even in changing ambient conditions. A wide range of signals is available. Accuracy is within 1 per cent. Transmitter can be mounted in left or right-hand position, and is reversible in the field. Fittings are available to adapt this instrument to all types of liquid-containing vessels. **Mason-Neilan, Div., Worthington Corp.**, Norwood, Mass.

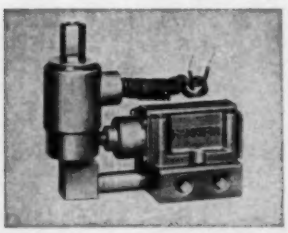
Circle 461 on Reply Card



X-Y Recorder

Designed especially for rack mounting, Model HR-95 X-Y recorder includes vacuum paper holddown, continuous 10 turn precision attenuators, and an electric pen lifter as standard features. It is available with either 1 millivolt per inch or 10 millivolt per inch amplifiers. It is also available with 10 or 100 millivolt full scale amplifiers for the 7-inch and 15 or 150 millivolt full scale amplifiers for the Y axis. Attenuators can be quickly disconnected for near infinite input impedance. Recorder utilizes standard 8½ by 11-inch graph paper or new paper divided into 100 by 150 minor divisions. Options include carrying case for use in upright or horizontal position and zener diode reference supplies. **Houston Instrument Corp.**, P. O. Box 22234, Houston 27, Texas.

Circle 462 on Reply Card

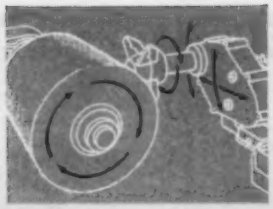


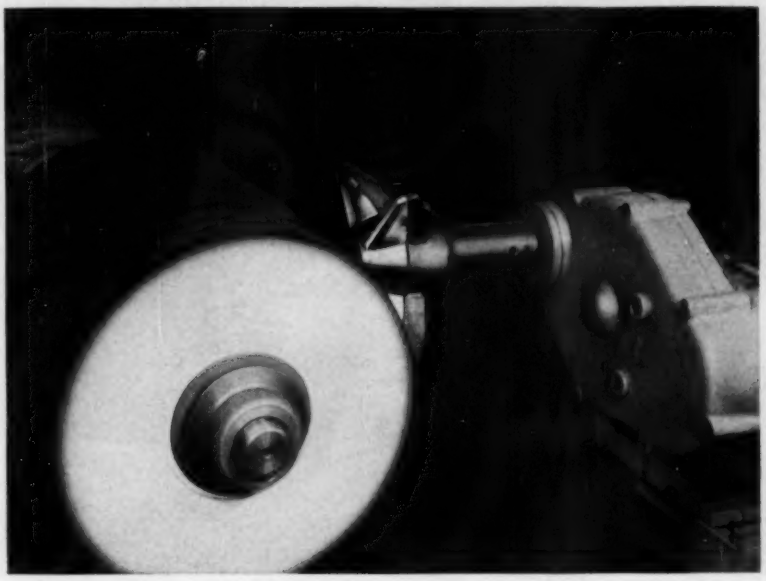
Solenoid Actuators

Line of explosion proof solenoid actuators for use in hazardous locations has been made available for Series CC pilot operated air valves. The actuators are suitable for Class 1, Group D; and Class 2, Groups F and G, hazardous applications. They are offered for both momentary and maintained contact, pilot-operated air control valves. **Hannifin Co.**, Dept. 142, 501 S. Wolf Rd., Des Plaines, Ill.

Circle 463 on Reply Card

ACME IN ACTION



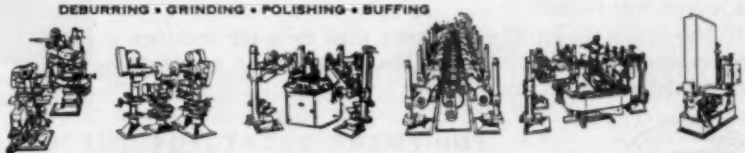


Doing more work with
Movement and Motion

The die-cast part being "mush" buffed above happens to be an automotive accessory having recessed, contoured surfaces. But it could be almost any other type of limited production part presenting similar finishing problems because the equipment performing the operation is a versatile Acme Semi-Automatic Polishing and Buffing Machine. Note that the ruggedly built work holding unit has an adjustable horizontal stroke that distributes wear evenly across the buffing wheel. Note, too, that the exclusive Acme oscillating head attachment simultaneously rotates the part and moves it vertically above and below the center line of the wheel to assure maximum coverage, greater uniformity of finish. Matter of fact, this unique combination of movements and motions—this added Acme action—does so much more work so much better that two operations can often be combined into one!

Want complete information about this and other Acme semi-automatic finishing equipment? A catalog is yours for the asking.

DEBURRING • GRINDING • POLISHING • BUFFING



Semi-Automatics Rotary Automatics Straight Line Automatics Flat Surface Polishers

Comprehensive catalogs available upon request. Write, wire or call:

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Leading Producers of Automatic Polishing, Buffing and Deburring Machines Since 1910

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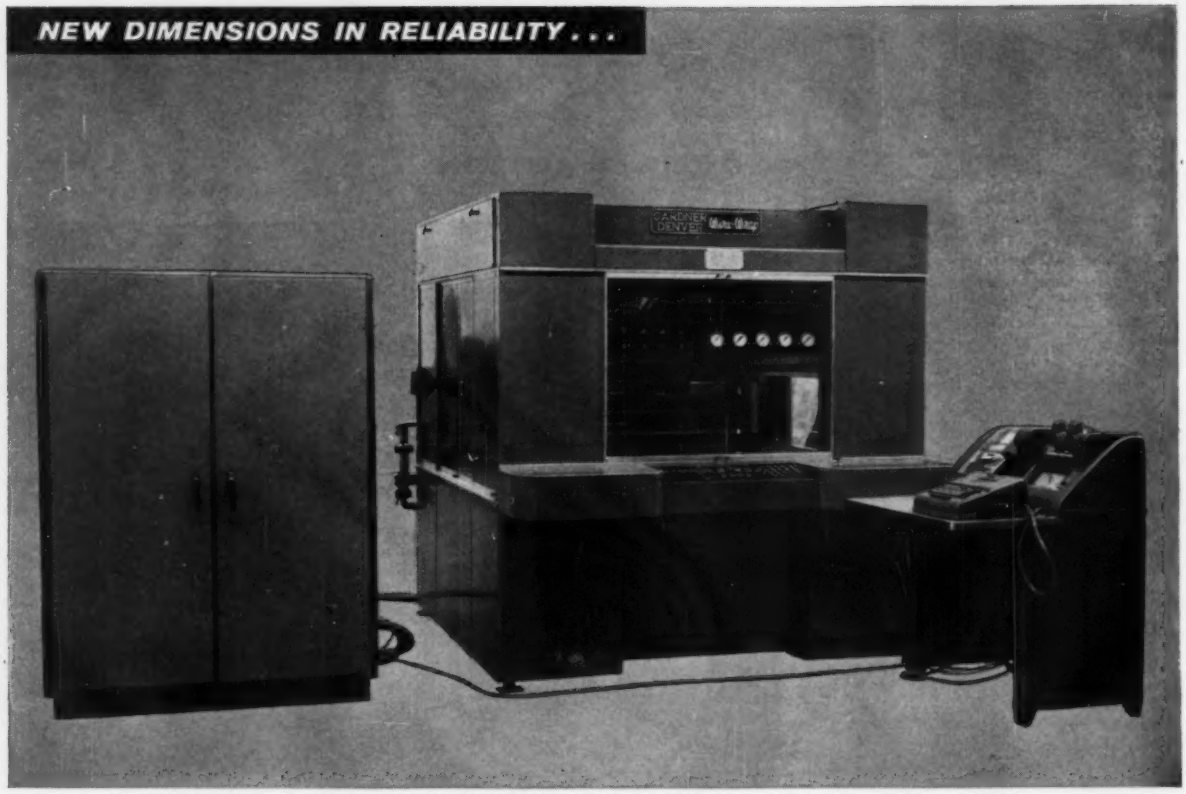
NEW DIMENSIONS IN RELIABILITY . . .



Gardner-Denver "Wire-Wrap" machine with control system that utilizes punched cards to wire complex computer boards

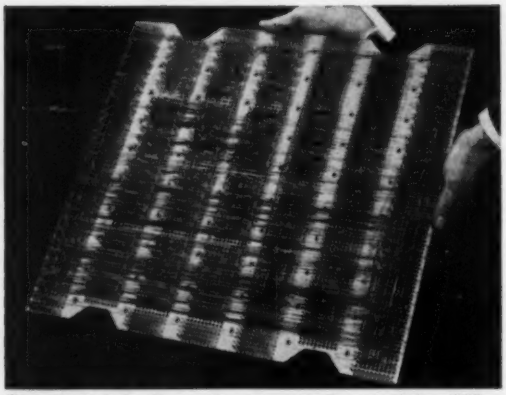
Automate complex wiring systems with Gardner-Denver Wire-Wrap® Machines

Gardner-Denver has added new dimensions to the reliability of complex electrical connections with automatic "Wire-Wrap" machines . . . for both commercial and military applications.

One machine wires complicated modular boards fast—in almost any pattern you can think of . . . makes literally thousands of connections in a small space. Machines are used for both commercial and military applications.

And these connections are the most reliable in the world—because they're solderless wrapped connections. They're lastingly secure, conquer vibration failure and corrosion. More proof of superiority? Over a billion connections without a reported failure.

If you build electrical equipment that calls for complex connections which must be reliable, write for an appointment with one of our engineers.



Complicated back panel—automatically wired by "Wire-Wrap" machine contains 2480 wires and 4960 connections.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

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AUTOMATION

catalogs and literature

Free copies available from manufacturer. Use convenient Readers' Reply Card.

Multi-Point Gages

Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill.—4 page pamphlet—Data are given in Bulletin 322.11 on a line of multi-point gages for indicating draft, pressure, differential, and temperature. Bulletin describes the gages, discusses their features in detail, and illustrates them in cut-away photographs. Standard scale ranges are listed. Diagrams and numerical data on mounting dimensions are included as well as diagrams and text on gage installation.

Circle 464 on Reply Card

Digital Shaft-Angle Encoders

Computer Control Co. Inc., 983 Concord St., Framingham, Mass.—8 page bulletin—Catalog, designated Dicotron, contains specifications and technical descriptions of linear and sine-cons[i]ne precision optical encoders for converting angular position information into binary code. Also included are encoder principles of operation, applications, packaging features, and relationship between disc coding and degree of accuracy. Auxiliary test sets and power supplies are described.

Circle 465 on Reply Card

Bucket Elevators

Kari-All, Div., Springfield Welding Co. Inc., 8 Commerce St., Springfield, N. J.—4 page pamphlet—Two vertical lift bucket elevators designed for loading mixers or packaging machines, bins, grinders, or sifters; for lifting material from floor to floor; and for automating process operations, are covered in this bulletin. Diagrams show both centrifugal discharge and positive discharge type units. Pictured is a sanitary constructed, stainless steel bucket elevator for use in the food, chemical, and pharmaceutical industries.

Circle 466 on Reply Card

Synchronous Motors

Bodine Electric Co., 2500 W. Bradley Place, Chicago 18, Ill.—20 page booklet—Bulletin 1036 describes the construction and operation of 385 different types and models of a line of synchronous motors. The motors are available in ratings from 1/2000 to 1/6 hp and in two basic types of construction—reluctance and hysteresis. Included in the bulletin are speed-torque curves, dimensional drawings, wiring diagrams, listings, and photographs of all motors in the line. Performance characteristics are discussed.

Circle 467 on Reply Card

Drilling and Tapping Units

Hypneumat Inc., 647 W. Virginia St., Milwaukee 4, Wis.—32 page catalog—Bulletin 6100 contains data regarding a line of high-speed automatic drilling and tapping units. Technical information, specifications, drill thrust charts, tapping-threading data, typical circuits, and applications are provided. Dimensional drawings of the various available models are also furnished.

Circle 468 on Reply Card

Ferrous Traps

Eriez Mfg. Co., 1945 Grove Drive, Erie 6, Pa.—6 page pamphlet—Powerful, permanent, magnetic devices which provide continuous protection for liquid lines and processing equipment threatened with iron contamination are described in Bulletin B-38. Magnetic filtration and wet separation equipment are covere[d]. Details are given on a Model L-2-F ferrous trap which combines magnetic separation of iron with a bronze filter for removing nonferrous materials. Diagrams show suggested installations for the various devices.

Circle 469 on Reply Card

Industrial Relays

General Electric Co., Schenectady 5, N. Y.—12 page booklet—Bulletin GEA-7329 provides information on a new 10-ampere, 300v industrial relay designed to cut control panel space requirements. With the relay, need for a wiring trough is eliminated. Changing of contacts and coils for greater flexibility and reduction of inventory costs are also discussed, along with the ease of making up new forms from basic two-pole and four-pole relays.

Circle 470 on Reply Card

Spring Cost Control

Associated Spring Corp., Bristol, Conn.—16 page booklet—Brochure is designed to aid producers of products containing springs in controlling costs of handling, quality, and procurement. Included is an explanation of custom packaging for various spring types to eliminate tangling and deformation, ease inventory counts, assure safe stock levels, and facilitate production line dispensing. A section of the guide illustrates new techniques and instrumentation for assuring quality levels suited to customer service and design needs. Procurement advantages stemming from single-source responsibility for a variety of components normally associated with springs are also described.

Circle 471 on Reply Card

Radiant Heat Processing

Fostoria Corp., Dept. 109, 1200 N. Main St., Fostoria, Ohio—8 page bulletin—Brochure 61-330 explains the principle of radiant heat and describes a line of equipment designed for utilization of the electric infrared radiant heating process. Applications of this equipment include use in such fields as paint baking, food, plastic, adhesive, electronic, printing, paper, paper converting, and textile. Photographs illustrate a number of applications.

Circle 472 on Reply Card

Vibratory Parts Feeders

Elk Engineering Works, St. Marys, Pa.—4 page pamphlet—Brochure provides information on a line of vibratory parts feeders designed for oriented position, single-line feeding of parts to various automatic machines. The feeders can handle a wide assortment of parts made of practically any material—metal, wood, glass, plastic, etc. Photographs illustrate the various models available. Units are electrically powered.

Circle 473 on Reply Card

Self-Aligning Bearings

Southwest Products Co., 1705 S. Mountain Ave., Monrovia, Calif.—60 page catalog—Catalog 551 covers a line of Monoball self-aligning bearings and rod end bearings. Charts indicate specifications of

AROUND, AROUND IT GOES...

PDC
"AUTOMATIC"
11" Dial Assembly Press
1 Ton at 75 p.s.i.

Direct double-action guided ram
Press head with 2" stroke, 3" throat
Standard risers available to increase shut height

A PROVEN FACT: the PDC Automatic Dial Assembly Presses *increase* production and *lower* costs. Proven in production for many years. Can be either hand-fed or hopper-fed.

This Standard Dial Assembly Press is for operations such as

• **Assembling** • **Staking** • **Riveting**
• **Pressing** • **Forming**

Write **TODAY** for new Catalog 60, for designers and engineers

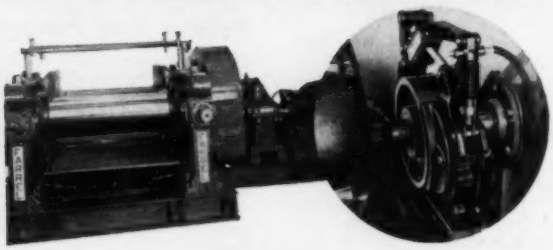
FEATURES: • Fast • Rugged • Economical
• Safety Drive • 8 stations
• Hardened and ground round ram with banjo guide
• Variable speed, 18-36 i.p.m.

This machine is also available with combination press-stake heads, impact heads and spinner heads.

PRECISION DETROIT COMPANY
20100 SHERWOOD DETROIT 34, MICHIGAN

Circle 723 on Reply Card

WAGNER® EMERGENCY BRAKE SYSTEM



Stops "Inrunning rolls" within safety limit

A Wagner® A/H Emergency Brake System protects the operator of this Farrel-Birmingham rubber mill against the hazards involved in operating machinery with inrunning rolls. An industrial-type brake is applied by an air-operated hydraulic power cluster to smoothly stop rolls well within the limit set by safety codes. The Wagner system minimizes strain on the machine drive, and incorporates safety devices that provide protection in the event of power failure or loss of air pressure.

Wagner brake systems are easy to install . . . don't need special motor starters or controls, or direct current. Need little care, too . . . there is practically no lining wear; no heavy solenoid coils to burn out.

Apply these systems to your rubber or plastic mills, refiners, washers, crackers. Available with 6, 8, 10, 14, or 18 inch diameter brakes. Get full details from your Wagner Sales Engineer.

Wagner Electric Corporation
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Circle 724 on Reply Card

a number of different series. Data are included on a Dyflon Series of plastic alloy insert, self-lubricated bearings available in a variety of plain or rod end types. Bore sizes are offered up to 6 inches and ultimate static loads up to 4,600,000 lb. Construction materials include stainless steel, plastic alloys, and chrome alloy steels.

Circle 474 on Reply Card

Computing System

Computer Div., Bendix Corp., 5630 Arbor Vitae St., Los Angeles 45, Calif.—6 page pamphlet—Brochure, designated BSP 07611, illustrates the hardware, software, and service features of a G-20 computing system. Details are provided on the overall system as well as on its various components. Bulletin also provides data on this company's customer support program, including a program library, training services, and on-site maintenance teams.

Circle 475 on Reply Card

Pneumatic Dispensers

Lincoln Engineering Co., 4010 Goodfellow Blvd., St. Louis 20, Mo.—36 page catalog—Line of air-powered equipment for materials dispensing applications is outlined in Catalog 42. Covered are pumping systems to dispense paint, cold roofing materials, food materials, caulking compounds and sealers, mastic adhesives and glues, vinyl material for plastic molding, inks, underbody coatings, sound deadeners, and similar fluid or semifluid materials. Also described are various accessory devices such as hose, air controls, couplers, etc.

Circle 476 on Reply Card

Strain Measuring Techniques

Brush Instruments, Div., Clevite Corp., 37th and Perkins, Cleveland 14, Ohio—20 page booklet—Booklet SR describes the application of a line of strain gages and transducers for accurately recording strain, tension, thrust, load, torque, etc. Basic strain recording circuits are shown for recording from one, two, or four active gages, and techniques used to obtain precise recording of both static and dynamic strain phenomena are explained. Also described are circuits for temperature compensation and for elimination of errors in Wheatstone bridge circuits. An appendix provides a guide for the selection of specific gages.

Circle 477 on Reply Card

Heat Treating Process

Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.—4 page pamphlet—Spin/hard heat treatment of sprockets, gears, traction wheels, rollers, and other products requiring hardened areas for high wear resistance is the subject of Folder 2922. This heat treatment produces a minimum hardness of 55 Rockwell C, ⅜ to ½ inch deep, on iron and steel castings and fabricated components from 8 to 42-inch diameter. It hardens wearing areas only and allows the remainder of a component to retain its machinability. Spin/hard treated components are used extensively on bucket elevators, apron, flight and drag conveyors, and many types of drive and conveyor chain.

Circle 478 on Reply Card

Paper Inspection Equipment

Kohler Coating Machinery Corp., 9701 Cleveland Ave. N.W., Greentown, Ohio—6 page pamphlet—Data are contained in Bulletin KCEA-2 on a line of paper inspection equipment, designated Inspectasort and Inspectalarm. Inpectasort is applied directly to a sheeter to detect and remove faulty sheets automatically. Inspectalarm is applied to a paper machine. It detects, signals, flags, counts, and records faults for manual removal at the winder; or evaluates an entire reel to determine whether or not it should travel through Inspectasort where faulty sheets are removed automatically.

Circle 479 on Reply Card

Flexible Conveyors

Power-Curve Conveyor Co., 2185 S. Jason St., Denver 23, Colo.—86 page catalog—Catalog 567 describes a line of powered flexible conveyors used to load bags and packages into box cars and trucks. It includes telescoping conveyors, multipurpose systems, car-loading stackers, mechanical palletizers, in-card palletizing, bag flattening and elevating, sorting and mixing conveyors, etc. Typical floor plans are shown as well as product photographs and a list of installations.

Circle 480 on Reply Card

Marking Equipment

Industrial Marking Equipment Co. Inc., 655 Berriman St., Brooklyn 8, N. Y.—4 page pamphlet—Brochure shows a variety of equipment for solving marking, dating, and coding problems. It features 28 photographs in which these machines are shown and briefly described. Some of the units pictured are: A number of different flexographic imprinting machines for marking cartons, plastics, bricks, etc.; case sealer marking attachments; coding devices for packaging machines; printers for multiwall bags and cartons; imprinting attachments for bag filling machines; etc.

Circle 481 on Reply Card

Electrical Connectors

AMP Inc., Eisenhower Blvd., Harrisburg, Pa.—12 page booklet—Presented in this folder are three separate lines of multiple connectors. Fastin-Faston multiple connectors are widely used in both the appliance and automotive industries. Containing 1, 2, 6, or 8 separate and fully insulated circuits, the connector's quick connect/disconnect feature is especially suited for high-production, assembly line methods. Ampeez multiple circuit connectors are ideally suited to the field of major appliance equipment. They are available in a choice of 7, 14, and 20-circuit configurations. AMP-Lok multiple connectors have a wide variety of uses including television receivers, computers, X-ray machines, and business machines.

Circle 482 on Reply Card

Control Valves and Actuators

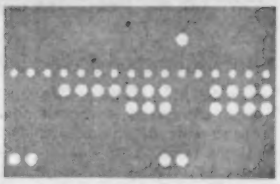
Fisher Governor Co., P. O. Box 307, Marshalltown, Iowa—64 page catalog—Bulletin E600 covers a line of control valves. Described are pneumatic diaphragm and piston actuators and a wide variety of valve body assemblies. Ac-

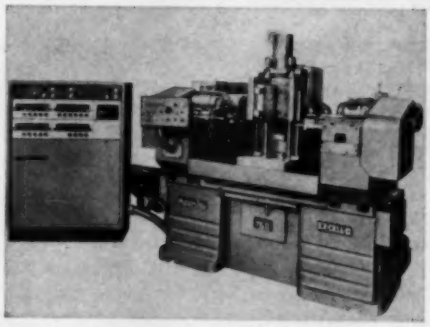
Rheem Electronics

NUMERICAL POSITIONING CONTROLS

Up to 6 Axes

Competitively Priced!





Rheem Numerical Control with Excello Model 758 Numera-trol boring machine.

VERSATILE

One system fits many machines . . . offers savings in operator training, planning, maintenance.

Modular construction by axis
Different resolutions available
High positioning speed
Feed rate control available
Large travel distances
No stepping switches used
Tape information distributed electronically
Decimal display of tape information
Virtually unlimited auxiliary functions
Automatic, semi-automatic, and manual operation modes

■ Reduce lead time ■ Improve product quality ■ Eliminate expensive jigs and fixtures ■ Reduce scrap loss ■ Make small lots economical ■ Minimize inventory and re-run problems

Rheem Numerical Control with Burgmaster 25AHT turret drilling machine. Complete 2 or 3-axis systems available.

Write for full information TODAY!

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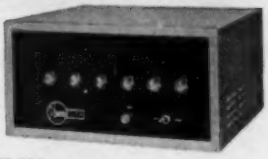

Designed to meet the requirements of operator controlled machines including retrofit on existing machines and inspection machines. Allows operator to position machine more rapidly and with greater accuracy, reduce operator fatigue, and avoid errors associated with reading of dials. For partial automation in both small and large shops. Available for one, two, or more axes of motion with typical resolutions of 0.001 or 0.0001 inches.

Rheem electronics

A division of Rheem Manufacturing Company

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SPring 6-1800

Circle 725 on Reply Card

cessories such as valve positioners, handwheels, electropneumatic transducers, etc., are included. Booklet contains a discussion of valve body and trim materials, a description of various styles of valve plugs, pressure-temperature ratings, maximum pressure drop tables, and performance data including frequency response.

Circle 483 on Reply Card

Shaft-Mounted Speed Reducer

Dodge Mfg. Corp., Mishawaka, Ind.—4 *page pamphlet* — Small shaft-mounted Torque-Arm speed reducer is subject of Bulletin 602A. The TD025 is designed for shafts 1½ inches or less in diameter and for power requirements up to 1 hp at 90 rpm. Reduction ratio is 24.89:1, and output speeds range from 10 to 90 rpm. Reducer can also be flange mounted. A table of recommended V-belt drives permits easy selection of total speed ratios up to 175 to 1.

Circle 484 on Reply Card

Solenoid Valve Data

Automatic Switch Co., Florham Park, N. J.—16 *page booklet*—Form V5073RI covers a line of 2, 3, and 4-way solenoid valves developed since issuance of the company's present catalog. Features are listed and applications explained. Also included are dimensional drawings for the various units.

Circle 485 on Reply Card

Electronic Control System

Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., Waltham 54, Mass.—2 *page pamphlet*—System for indicating and controlling pressure, torque, and load is subject of Data Sheet 4402. This system is easily connected for applications where simplicity is needed, space is limited, and moderate accuraces—from 2 to 3 per cent of full scale—are acceptable. Bulletin illustrates the three components which comprise the system. These include an amplifier, meter, and control. Specifications, features, and prices of these units are given.

Circle 486 on Reply Card

Hydraulic Turret Drills

Burgmaster Corp., 15001 S. Figueroa St., Gardena, Calif.—16 *page booklet*—Line of 6 and 8-spindle automatic hydraulic turret drilling machines is covered in this catalog. Details are provided on many optional features and attachments, including automatic tape controls that adapt the machines to wide ranges of work. Special machines built from standard components for specific work are also shown and case histories of actual installations are provided.

Circle 487 on Reply Card

Radiant Heat Burners

Selas Corp. of America, Dresher, Pa.—20 *page booklet*—Detailed in Bulletin DB-2 is a line of Duradiant burners that beam radiant heat to workpieces without flame impingement. A listing of the types of burners available is provided, along with photographs and dimension and capacity tables for each series. Included are: Burners for open firing, for line arrangement, threaded block for semi-furnace construction, light duty panel type for semi-furnace construction, and furnace wall type.

Circle 488 on Reply Card

Controlled Feeding Systems

B-I-F Industries, P. O. Box 276, Providence 1, Rhode Island—8 *page bulletin*—Data are contained in Bulletin 4.20-1 on a line of feeding, weighing, blending, and proportioning equipment for the controlled feeding of liquids and solids in process industries. Photographs of various pieces of equipment are furnished. Also included are a number of diagrams indicating operational sequence of typical process systems and continuous loss-in-weight feeding systems.

Circle 489 on Reply Card

Assembly Machines

Swanson-Erie Corp., 814 E. Eighth St., Erie, Pa.—20 *page booklet*—Described in this booklet is a line of multistation automatic assembling and processing machines. Both standard and special models are illustrated as well as an indexing machine chassis made in stock models ready to apply to special automatic machines requiring intermittent work transfer motion. Description covers standard machines for performing operations in the manufacture of incandescent and fluorescent lamps and also special ma-

GAGE PAGE

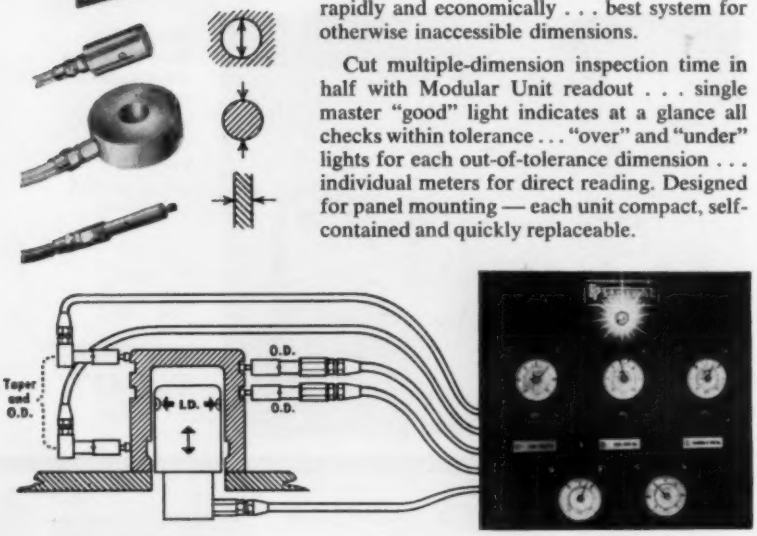
A Quick Run-down of New Gaging Ideas

THE MOST PRACTICAL WAY

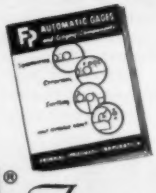
. . . to check dimensional relationships such as hole location, taper, center distance, etc., is to gage with Air.

The FEDERAL Air Gaging System combined with electric control does the job rapidly . . . embraces complete selection of building-block components . . . measures inside and outside diameters, eccentricity and squareness — rapidly and economically . . . best system for otherwise inaccessible dimensions.

Cut multiple-dimension inspection time in half with Modular Unit readout . . . single master "good" light indicates at a glance all checks within tolerance . . . "over" and "under" lights for each out-of-tolerance dimension . . . individual meters for direct reading. Designed for panel mounting — each unit compact, self-contained and quickly replaceable.



For complete specs, dimensions — the *whole* story — send for Catalog 60 AM.



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1311 EDDY STREET, PROVIDENCE 1, R. I.

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Dial Indicating, Air, Electric, or Electronic—for Inspecting, Measuring, Sorting, or Automation Gaging

chines for processing such diverse products as nursing units, electronic parts, bowling balls, typewriter components, and razors.

Circle 490 on Reply Card

Electric Flowmeters

Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.—2 page pamphlet—Specification Sheet S200-3a presents data on four basic models of electric instruments with pneumatic outputs to control liquid flow or liquid level, and record and/or indicate these variables. Two models also record fluid temperature and pressure, respectively. A variety of control forms, scale ranges, and accessories are available.

Circle 491 on Reply Card

Vibratory Finishing Line

Pangborn Corp., Hagerstown, Md.—12 *page booklet*—Details and specifications on a line of air-cushioned vibratory finishing equipment are outlined in Bulletin 1703. Photographs of typical parts before and after vibratory finishing illustrate scope of process. Cut-away drawings indicate features of the machines. Details are provided on an automatic continuous-process machine designed to handle large-quantity production requirements.

Circle 492 on Reply Card

Fluid Power Cylinders

S-P Manufacturing Corp., 30201 Aurora Rd., Cleveland 39, Ohio—4 page pamphlet—Series A2 pneumatic and hydraulic cylinder line is subject of Bulletin 10C. With the aid of a cutaway cylinder illustration, important engineering developments, both in cylinder construction and operating advantages, are detailed. The line is rated at 250 psi air and up to 2400 psi hydraulic. It is available in 11 bore sizes from 1½ through 14 inches with 25 mounting styles and a wide range of piston rod diameters.

Circle 493 on Reply Card

Pressure Hose Fittings

Aeroquip Corp., Jackson, Mich.—6 page pamphlet—Data are contained in Bulletin 651 on a detachable, reusable fitting for high pressure hose assemblies. Designed especially for industrial markets such as construction equipment and heavy automated machinery, the fitting is recommended for a wide range of high pressure hydraulic and pneumatic applications, as well as for fuel and lubrication systems. The Iron Mike fitting is available in ten end fitting styles for hose sizes ranging from ¾ inch to 2 inches.

Circle 494 on Reply Card

Adjustable-Speed Drive Data

General Electric Co., Schenectady 5, N. Y.—32 page catalog—Brochure GEA-6999 entitled "Adjustable-Speed Drives—How to Analyze, How to Compare, and How to Select" defines adjustable-speed drives and their role in industry. It deals in detail with product description and application, factors in drive selection, and examples of and recommendations for special applications. The line of drives covered ranges from 1/20 to 1000 hp. Featured in the booklet is a price-comparison table, reflecting typical drive price curves plotted against drive horsepower.

Circle 495 on Reply Card

Gas Pressure Regulators

Air Reduction Sales Co., Div., Air Reduction Co. Inc., 150 E. 42nd St., New York 17, N. Y.—40 page catalog—Line of regulators for the control of industrial gases is covered in Catalog 806. Information on accessory equipment available with the various regulators is also provided. A number of different models are illustrated.

Circle 496 on Reply Card

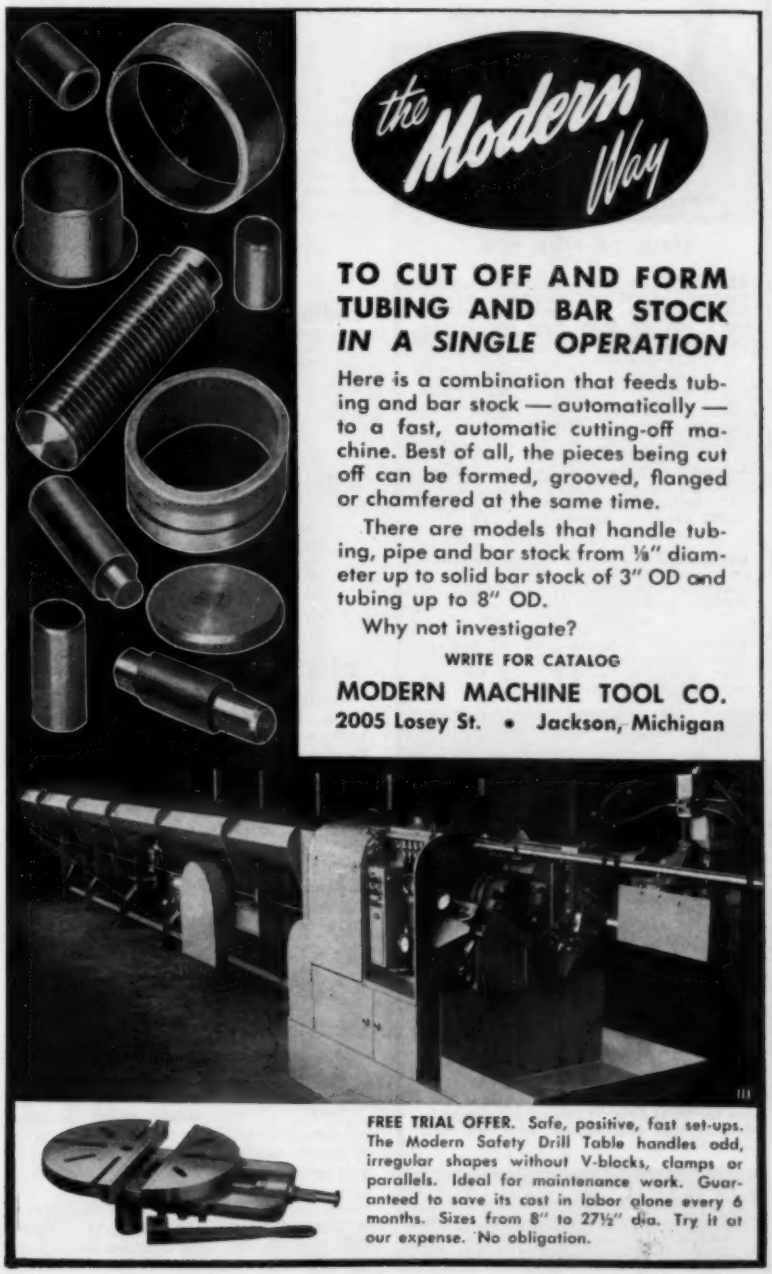
Numerical Positioning Controls

Electronics Div., Rheem Mfg. Co., 5200 W. 104th St., Los Angeles, Calif.—12 page booklet—A control block diagram and step-by-step explanation of the use of automatic numerical positioning controls for machine tools are provided in Booklet M-104. Advantages of utilizing these controls are explained. Various components of a typical system are illustrated and discussed.

Circle 497 on Reply Card

Electron Beam Welder

Sciaky Bros. Inc., Dept. E-B, Chicago, Ill.—6 page pamphlet—Electron beam welder, designated Model VX-20-30-48, is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Here is a combination that feeds tubing and bar stock — automatically — to a fast, automatic cutting-off machine. Best of all, the pieces being cut off can be formed, grooved, flanged or chamfered at the same time.
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FREE TRIAL OFFER. Safe, positive, fast set-ups. The Modern Safety Drill Table handles odd, irregular shapes without V-blocks, clamps or parallels. Ideal for maintenance work. Guaranteed to save its cost in labor alone every 6 months. Sizes from 8" to 27½" dia. Try it at our expense. No obligation.

Circle 727 on Reply Card

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PSC QUICK DISCONNECTS give you the fastest, easiest and most economical means of connecting or disconnecting supply lines.

FAST, SIMPLE, one hand connect or disconnect. Automatic locking forms a high pressure, leak-proof connection.

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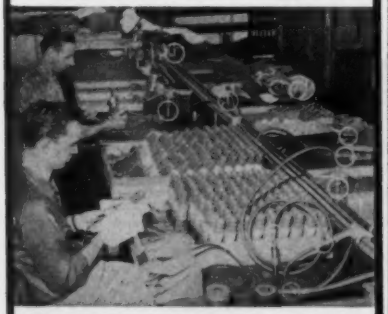

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Circle 728 on Reply Card

discussed in Bulletin 344. In addition to welding by fusion, the equipment can be used for melting, grain refining, stress-relieving, out-gassing, cutting, overlaying, metallizing, crystal growing, and vacuum brazing. Elements comprising a typical electron beam welding facility are listed and explained. Multiple electron gun, entirely contained within the atmosphere of the welding chamber, will weld at any angle. Materials ranging from 0.005-inch thick tantalum to ¾-inch plates of stainless steel and 4340 steel can be welded by the equipment.

Circle 498 on Reply Card

Pushbutton Pulse Switches

Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.—2 page pamphlet—Data Sheet 194 reviews a millisecond-length electronic pulse switch series, designated 1PB3000. This series produces one square-wave pulse with each operation. It presents a completely noise-free, pre-engineered switch-circuit package for many applications in the electronic field such as pulsing of relays and solenoids, induction heaters, welding equipment, digital computers, x-ray, and miscellaneous sequencing in both solid state and electromagnetic circuits.

Circle 499 on Reply Card

Sliding Gate Valves

OPW-Jordan Corp., 6013 Wiehe Rd., Cincinnati 37, Ohio—8 page bulletin—Line of Sliding Gate control valves is covered in Catalog DCV-1. The valves are available in from ¼ to 6-inch sizes. Catalog includes pressure and temperature ratings, valve features, capacity charts, names of parts, dimensions, flow chart, diagrams of various hook-ups, sample specifications, information on when to use a controller and when to use a positioner, and an explanation of the valve's Sliding Gate seat.

Circle 509 on Reply Card

Industrial Manipulator

Consolidated Controls Corp., Bethel, Conn.—6 page pamphlet—Covered in this bulletin is an industrial robot designed to handle objects weighing up to 25 lb. At reduced speed, 75-lb objects can also be handled. The Unimate has five degrees of freedom enabling it to grasp an object in any position within a swept volume of 350 cu ft. Applications performed by the unit include such jobs as assembling of parts, feeding a lathe, operating a welding gun, feeding a forging press, and loading a conveyor.

Circle 501 on Reply Card

Electric Power Shift

Western Mfg. Co., 3400 Scotten Ave., Detroit 10, Mich.—2 page pamphlet—Data are contained in this bulletin on a Model 18700-EC electric power shift designed for heavy duty applications. The unit is equipped with electromagnetic clutches that provide speed changes and reversing under power, without interrupting the power source. It is available in two, three, or four-speed changes with a maximum reduction of 10:1. Transmission is applicable to both general and special purpose

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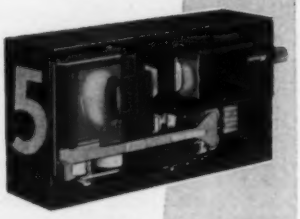
ALL DIGITS CAN BE READ FROM ANY ANGLE



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Specifications: 1⅜" high character, module size 1¾" x 3¼" x 6¾"

Price Complete from $50.00

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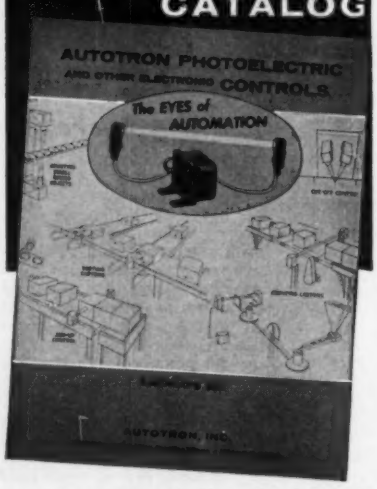

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Circle 730 on Reply Card

machine tools, and is used in such industries as chemical, rubber, food processing, steel, and glass.

Circle 502 on Reply Card

Press Overload Detector

Di-Matic Controls Inc., 100 Beadel St., Brooklyn 22, N. Y.—1 page bulletin—Applications and features of a fully adjustable press overload control are described in Bulletin MID-2. This device can be used with any basic model in this company's line of press controls of the 100 or 200 series. It provides a means of preventing costly damage to dies due to overload. Operating details of the detector are presented. In addition, sensor unit installation and cam-switch arrangement are described.

Circle 503 on Reply Card

Heating Controls

General Controls Co., Sales Promotion Dept., 801 Allen Ave., Glendale 1, Calif. —98 page catalog—Catalog 608.426 provides data on a line of heating controls. Introduced are Sheer Line thermostats offering a combination of features—fixed or adjustable heat anticipation; mercury switch, snap-action or thermopoised contacts; 24-volt, millivolt, or line voltage models. A Midgitrol line of compact gas valves is also presented. Lightweight switching mechanisms and a TD Series of time delay relays are also discussed.

Circle 504 on Reply Card

Hydraulic Web Guide

Stanford Engineering Co., Box 369, Salem, Ill.—8 page bulletin—Manual provides detailed technical and specification data on a P-H Series automatic web guide. It contains various illustrations and an introducton to hydraulic web guiding, principle of operation, models available, application, construction, and installation and mantenance instructions.

Circle 505 on Reply Card

Pneumatic Receiver

Bristol Co., Waterbury 20, Conn.—2 page pamphlet — Product Data Sheet A113.1.3-10 reviews a Series 654 Metagraphic pneumatic receiver which can be used as a single unit or gang assembled for either horizontal or vertical mounting. The strip-scale instrument saves panel space and permits simultaneous indication of co-ordinated variables. Drawings illustrate construction details and design features.

Circle 506 on Reply Card

Material Level Control

Electronic Controls Div., Flo-Tronics Inc., 712 W. Ontario Ave., Minneapolis 3, Minn.—2 page pamphlet—Bulletin describes and illustrates a Model L201 Flo-Level material level control. This unit may be used with liquids and dry or semi-dry bulk materials in bins, tanks, hoppers, or other containers. It is ideal for lightweight materials such as plastic pellets or powders as well as heavier materials.

Circle 507 on Reply Card

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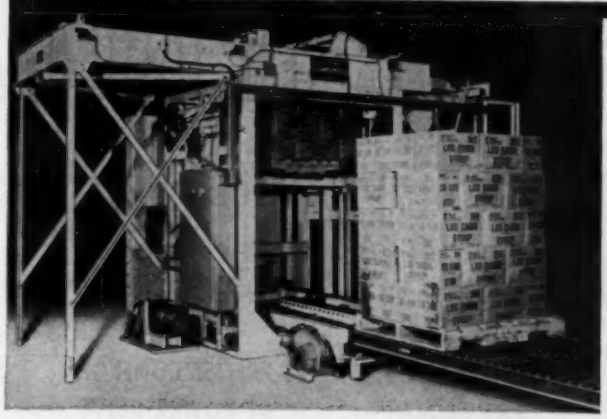
that are delivering outstanding performance in the food and chemical industries



The machines shown here are two of a complete line of Mathews Automatic and Semi-Automatic Pallet Loaders.

Whatever your package handling problem, Mathews will build the equipment to do the job best for you. You'll get a complete conveyer engineering service, from proposal through installation, and equipment that will deliver outstanding performance. That is why we believe you get the most for your money when you buy Mathews Conveyers.

Send for Bulletin APL-60 for more pallet loader information

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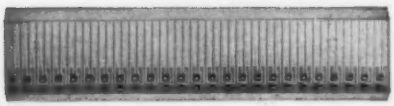
MATHEWS

Circle 731 on Reply Card

3 VITAL FACTORS IN NUMERICAL CONTROL!

1 - ACCURATE MEASUREMENT

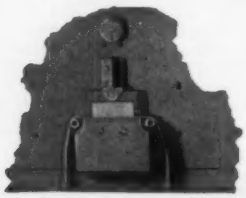


The linear transducers in the Sperry Control provide highly accurate measurement unaffected by age or wear. Made of a special glass/mica compound, these transducers have a coefficient of expansion similar to steel and consequently introduce no measurement error within the machine mass due to temperature changes.

2 - PRECISE CONTROL OF POWER DRIVE

The exclusive Sperry electro-hydraulic Servo Valve provides precise control of hydraulic cylinders or motors. The Sperry valve's unique construction eliminates linkages, springs and "dither".

3 - RAPID, RELIABLE DATA REDUCTION



Rapid, reliable data reduction is obtained through the use of the Sperry Tape Reader. This reader uses low pressure airflow to read punched tape. The air pressure also keeps the reader head and tape clean, thus avoiding reading errors due to dirt contamination. The Sperry block reader can read ten, twenty line blocks per second.

There is a fourth factor that is vital to any numerical control installation and that is *Systems Engineering*. Sperry's staff of servo systems engineers, strategically located across the country, is at your disposal to ensure the success of your particular application.

For more systems application data for your particular machine or process, write to:

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Circle 732 on Reply Card

AUTOMATION abstracts

POSITIONING CONTROL STANDARDS

By HARRY ANKENEY
Manager, Electrical Engineering
Giddings and Lewis Machine Tool Co.
Fond du Lac, Wis.

A PROGRAMMER who understands and uses all the features provided in a control is necessary to an efficient and economical numerical positioning control installation. The simple two-axis positioning control is a big help in reducing operator error, fixture cost, and manufacturing time; but it is only when a programmer can control all axes and auxiliary functions the way an operator does that the biggest payoff can be achieved. The control should have machining modes that permit fast, heavy cuts for roughing and fine, precision cuts for finishing. It should be possible to call for boring, drilling, tapping, and other cyclical operations by an auxiliary function. Feed rates, speeds, and even the tool should be programmable to enable numerical control to deliver its full potential.

The programmer starts with a drawing of the part to be manufactured and a manuscript that looks something like *Fig.* 1, on which he will enter the machine and operator commands. Now this may look complicated, but to keep the programmer's confusion to a minimum, Electronic Industries Association has a committee working on a standard that will make all manuscripts as similar as possible. The sequence of the columns and the code numbers used in the columns are all dictated. It may be two years before this standard is issued, but many of the principles are already worked out.

A combination of "tab sequential and word address" formats is called for by this standard. Tab sequential derives its name from the fact that a "tab" code is inserted at the start of each word, and a fixed data sequence is assigned for all commands. If any data is repetitious or not required, only the "tab" character need be punched in that word. The tape is made at the same time the operator's manuscript is typed. The typewriter is set up to print each word of the command in its assigned column. The tab key moves the carriage over to the next column before each word is typed. After the last needed word of any command, the carriage return key is pressed which causes the "end of block" character to be punched in the tape. In the control, tab characters are usually used to step a distributor which routes each word into the memory section designed for it.

Word address might more appropriately be called "letter address" because a different letter is used before each type of word. The control uses this letter to select which memory section to route a word into. The words may be given in any sequence, but a faster read-in time will usually be achieved with a given sequence. When this control tape is used to run a typewriter, the words do not align themselves in columns and the copy is more difficult to interpret. The operator's manuscript must be prepared separately.

With the combination format called for by the standards, a fixed data sequence is specified for all commands, and each word will contain a tab character and a letter. The tab characters used will align the manuscript, but these tab characters may be ignored by the control if it is decided to route the words on a word address basis. Likewise, the letter characters can be ignored if it is decided to use the tabs to route the words to their appropriate memory sections.

Starting in the left-hand column of *Fig.* 1, the sequence number is a three-digit number to allow for reference to any particular line or block of information. Each block constitutes a machine command. Some controls display this sequence number to help the operator follow the manuscript with regard to any instructions written in the right-hand column. All manuscripts must have this sequence number.

The next column is for Preparatory Functions. These are code numbers used to set up the control for various modes of operation such as drilling or tapping. Sometimes they are used to indicate plane selection or feed direction. This is the feature that allows the programmer to make a machine under tape control as valuable as a manual machine with the most skill-

MANUSCRIPT FOR MACHINE & OPERATOR COMMANDS. G&L 65-HS-T Machine

PART NO._____ OPER. NO._____ PART NAME_____ MATERIAL_____

PROGRAMMED BY_____ CHECKED BY_____ DATE_____ PAGE NO._____

SEQUENCE NUMBER	PREP FUNC	TABLE POSITION	HEAD POSITION	SADDLE POSITION	MILG. FEED	SPDL. FEED	SPDL. SPEED	TOOL FUNC	MISC FUNC	OPERATORS INSTRUCTIONS
n001	g12	x±1234567	y±1234567	z±1234567	f123	e123	s123	t123	m123	
n002										
n003										

Fig. 1—Areas in which programming standards can be obtained without hindering further progress include nomenclature, arrangement of columns on form, and "letter" address before program entries on form.

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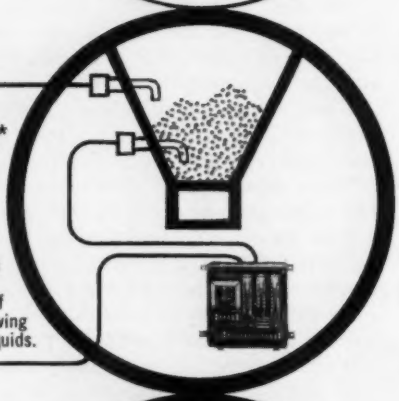

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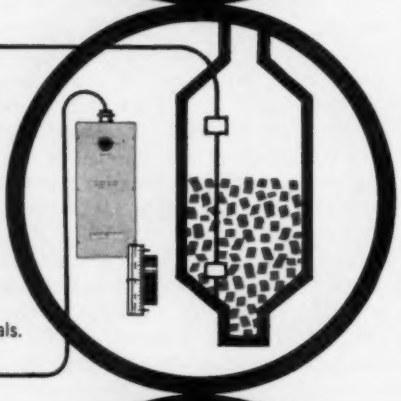

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INDUSTRIAL ELECTRONICS
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ful operator.

The next columns are used to set down dimensional information for however many axes are being controlled. These may or may not be preceded by a plus or minus sign and may consist of different numbers of digits. Even those with the same number of digits may differ because the position of the decimal point may be different. The period or decimal point should not be coded in the tape, though most controls will ignore it.

Following the dimensional columns are those applying to feed rates and speed. In these will be code numbers which will indicate the desired feed in inches per minute or inches per revolution and speed in revolutions per minute.

The EIA committee has worked out a three-digit code that can cover numbers from 0.0001 to 99,500. The second and third digit of this coded number are the feed or speed rounded to five digit accuracy. The first digit of the coded number has a value three greater than the number of digits to the left of the decimal point of the feed or speed. If there are no digits to the left of the decimal point, then the number of zeros immediately to the right of the decimal point is subtracted from three to provide the value of the first digit.

For example, 1728 is coded as 717; 7.82 is coded as 478; and 0.00876 is coded as 188. With a little practice, this code can be read directly. We hope control builders will arrange to accept these codes and cause the machine to provide the nearest possible feed or speed.

The column for Tool Function will have a code number for the tool to be selected in tool changing machines, or the number may be displayed to signal the operator which tool to put in the spindle.

Miscellaneous Functions are code numbers used to turn on the coolant, start the spindle, clamp the table, etc. An attempt is being made to standardize these numbers so they will mean the same thing to all controls.

In the last column is typed any information which the operator may need. On machines where the third axis is not controlled, this may tell him the depth of cut. If tools are not coded, this may tell him the tool to be used. Whatever the instruction, this is not coded in the machine control tape. The machine operator should receive a copy of the manuscript when he gets the job, and he should use the sequence number to correlate his instructions with the operation to be performed.

After the programmer has written down all the machine and operator commands necessary to make the part, he turns the manuscript over to a typist to prepare the media used to control the machine.

Tape Standards

Nearly all systems being designed today use an 8-channel, 1-inch-wide punched tape with the Flexowriter NC-1 code. This weights the first four channels, 1, 2, 4, and 8. All numbers are made up as binary coded decimals from combinations of these numbers. The other four channels are Parity, Zero, X and End of Block or Carriage Return. Letters are made up

from number combinations plus Zero or X or Zero and X. Besides numbers and letters, the principal codes used are plus, minus, period (decimal point), space, tab, and carriage return. Obviously, space, tab and carriage return do not make a mark on the manuscript.

A parity channel is used to make every row have an odd number of holes. If the code would otherwise result in an even number of holes, an extra one is thrown into the parity channel. On reading, the control checks the quantity of holes so that if it should miss one an even number would be read and an error indicated.

This is not the most efficient use of the holes available, but it does achieve a great deal of compatibility and interchangeability. I feel it is a big step forward from the many tape widths, special codes, and hand punching that prevailed not many years ago. Issuance of EIA standard RS-227 on dimensions of the tape meant users could not purchase a fairly expensive piece of tape preparation equipment with the assurance that they could use it to make tape for any control by specifying this EIA standard on their purchase order. Very shortly, EIA standards proposal 621 on tape code will be issued; then the user will be protected further.

From a paper entitled "Programming Numerical Positioning Control," presented at the 25th Annual Machine Tool Electrification Forum sponsored by Westinghouse Electric Corporation, Pittsburgh, April 1961.

THE PETROLEUM INDUSTRY LOOKS AT DATA PROCESSING

By T. V. LEARSON
Vice President & Group Executive
International Business Machines Corp.
New York, N. Y.

TO EVALUATE the progress and results of data processing investment in the petroleum industry, a list of questions was mailed to the presidents of 37 companies that represent about 80 per cent of the industry's total volume. Twenty-eight completed questionnaires were returned. The questions were designed to elicit what was thought of the past, what weaknesses were present and needed correction now, and where further emphasis was desired in the future.

The first question had three parts and was related to the fact that saving money over the old method is frequently a major consideration in installing data processing equipment.

Did equipment costs prove accurate? (Answers: Yes—20, No—2, Qualified—3, No answer—3)

Did programming costs prove accurate? (Answers: Yes—7, No—13, Qualified—4, No answer—4)

Did other expenses and/or savings materialize? (Answers: Yes—15, No—1, Qualified—7, No answer—5)

There is nearly unanimous agreement that the projected rentals and running times are close to actual experience once a system has been shaken down and is running under normal conditions. This indicates

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FAST * PRECISE * UNIFORM OUTPUT

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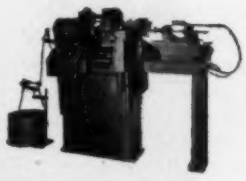

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- Bench, Pedestal, or Bed Types . . .
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- Six Basic Sizes—Full Range . . .
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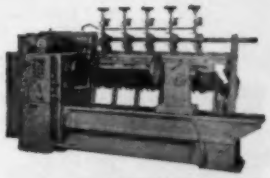

TRANSFORMER WINDER

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that the yardsticks in use for workload measurements are good tools with current data processing equipment on the market.

The comments indicated that manufacturers have tended to overstate the capacities of their machines, and that rated capacities are hard to obtain in actual practice. While these comments were not dominant, they do suggest that there has been some overselling and as such must be taken seriously.

The disparity on programming costs was attributed to such things as: Changes in the scope of the system during the execution phase; understating the detailed work required to analyze, define, and finally program the problem; lack of automatic programming system and utility programs; and slower compilations than expected.

One of the contributing causes to this disparity between programming estimates and costs was the tendency of the user organization to change its practices during the programming phase. This, of course, is a situation with which we shall have to live. Change is characteristic of every business organization, and we shall always have to accommodate ourselves to it even though it may have a sharp impact on programming costs.

Two problems are illuminated with which the computer industry must come to grips. The first is the need for better methods of documenting the problem. Too frequently we underestimate the work involved in documenting the job, in analyzing the documentation and in accommodating the system to it. We must find better ways of getting them done. The second problem relates to the need for better and more comprehensive automatic programming systems.

Though expected savings did materialize, certain factors were highlighted that tend to delay the realization of savings. These included: Constant change due to increased volumes, revision in results wanted, increased costs of material and manpower; costs of retraining displaced personnel; costs of maintaining the systems, procedures, and programs; and unanticipated need for manpower to handle machine setup.

Administrative Control

The second question had two parts and related to the fact that better control of operating and financial data is usually a major objective of many companies in installing data processing equipment.

To what extent was this objective achieved? (Answers: Yes—19, No—4, No answer—5)

Did the plan to achieve the objective have any major weakness? (Answers: Yes—2, No—16, Qualified—2, No answer to question—8.)

Better control of operating and financial data was a universal objective and it was largely achieved. An important by-product mentioned in the responses was the additional accuracy obtained through the editing and auditing of input data made possible with data processing.

The major weakness in some plans was apparently in the area of conversion from the existing to the EDPM system. Other impediments to progress in-

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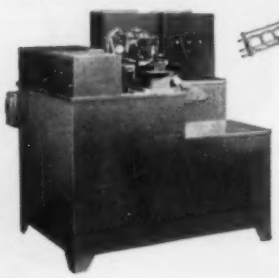

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cluded: Lack of trained personnel; lack of knowledge; state of the art; and decentralization of the business and authority.

The third question (in three parts) related to the fact that data processing equipment is being used to an increasing extent in the area of management science. This allows for the application of mathematical techniques in testing the dynamics in a business.

Has your company applied any of these techniques? (Answers: Yes—20, No—5, Qualified—1, No answer—2)

Is the supply of trained people retarding progress in this area? (Answers: Yes—10, No—11, Qualified—3, No answer—4)

Is there enough proof that this area warrants further investment? (Answers: Yes—18, No—5, No answer—5)

Refining simulation was one of the very first applications of simulation and modeling techniques. Beyond refining, linear programming techniques are being applied to production and distribution problems as well as planning and economic studies. The limiting factor is not a lack of trained manpower, but a lack of practical tools and techniques, a lack of appropriate data. To simulate a business situation, it is necessary to have far more data than can ordinarily be gleaned from accounting statistics. We must be able to describe mathematically the causes of business success and failure. And to do this, we must have data on such things as market forecasts, product development costs and a wide range of related activities. It is only when we assess the problem in terms of these needs that we realize the extent of our present shortcomings.

Accounting versus Engineering

The fourth question was related to the fact that 50 per cent of the usage of computers in the petroleum industry is on engineering and research problems and 50 per cent on accounting problems.

Would you comment on the comparative results achieved by accounting and engineering?

In the accounting area it has been possible to measure the results, since most data processing systems are part of a controlled program whose purpose it is to achieve savings. In research and engineering the effort is directed to the achievement of new results and the product is difficult to measure. But this difficulty in measurement did not inhibit predictions. It was estimated that research and engineering uses of data processing systems hold out the greatest promise of benefit to the company.

Equally important, the line which once separated engineering and accounting applications is becoming increasingly blurred. More and more, engineers, accountants, operations analysts, and mathematicians are learning to attack their common problems jointly with the aid of data processing systems. Inevitably, these tendencies will encourage the development of management science with greater emphasis on the use of simulation and model techniques. As these forces come into play, many of the difficulties commonly associated with bigness and complexity will disappear.

Considerations for the Future

The fifth question related to the fact that due to increased capabilities of data processing equipment, a centralized installation and/or communications between

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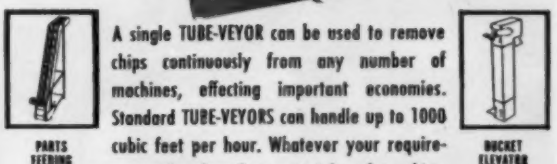

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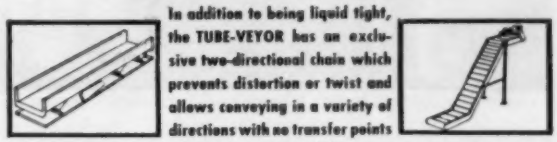

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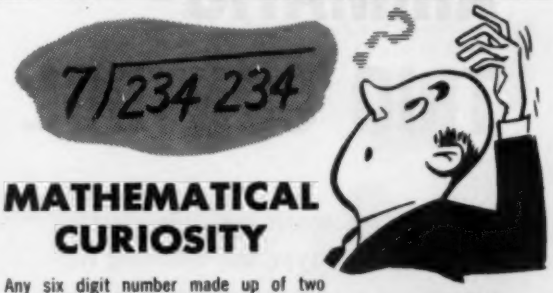

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installations appear to be the trend.

Is this of high priority in you company? (Answers: Yes—14, No—12, Qualified—2)

Are existing organizational structures challenged? (Answers: Yes—16, No—9, Qualified—2, No answer—1)

The divergence of opinion on priority was not especially surprising. Teleprocessing is a relatively new concept. Its uses are in the pioneer stage. It will call for a great deal more experimentation before its real potential can be estimated. In many instances, there has been a pronounced trend toward centralization in data processing installations. But many users who are now employing the mails and teletype between distant points have yet to be shown that the advantages of data communications justify the increased costs.

The overwhelming belief that organizational structures are challenged is understandable since the computer is fundamentally an instrument of control. When the pattern of control changes, we can surely anticipate parallel changes in our organizational structures. The solution here is an individual one.

The sixth question was related to the fact that the increasing capability of data processing equipment, particularly as it expands into the operational area of the business, frequently requires a higher level of knowledge of data processing equipment by top management if full advantage is to be gained.

Has this been a problem in your company? (Answers: Yes—9, No—16, Qualified—2, No answer—1)

There is a problem in communicating with top management in this area. Equipment manufacturers have long been sensitive to the problem. During the early days of data processing when it was restricted primarily to accounting, this need for undestanding was not particularly acute. But as we cross the line into management science, as computers burrow deeper and deeper into the nerve center of the business, it is essential that top management know the capacities of these systems and be aware of their limitations.

From a paper entitled "Looking Ahead in the Data Processing Industry," presented before Midyear Meeting of the Division of Finance and Accounting, American Petroleum Institute, New Orleans, June 1961.

THE PROPER TIME TO REDUCE COST

By JOHN F. RINGO
Convair Division
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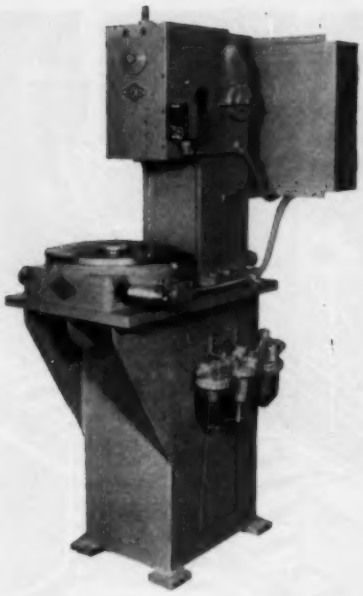

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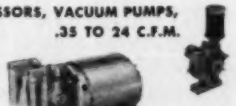

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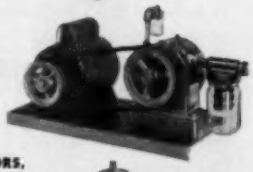

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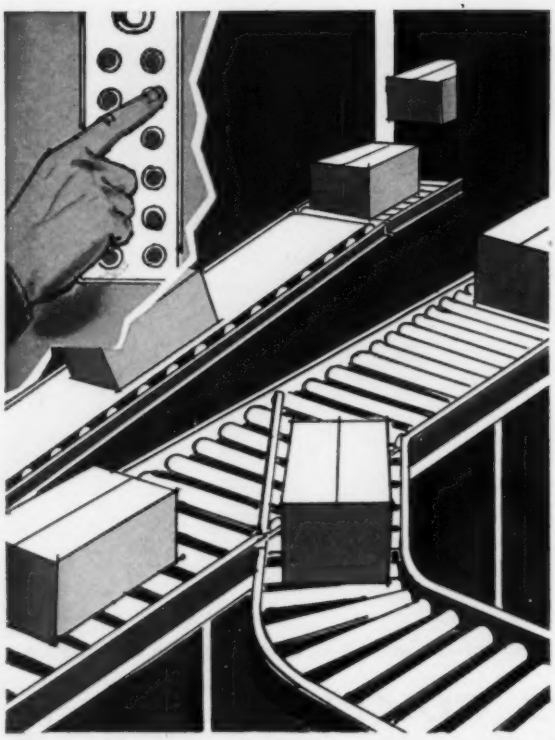

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Of course, to be able to choose the best alternative you must have: 1. Time to develop alternatives. 2. Cost data available so that a comparison can be made between alternatives. Regardless of how much time is allowed to develop alternate decisions or how readily available are comparative costs, they are useless unless properly used. Assume that you have developed value-consciousness in all your design engineers through the use of value engineering seminars. You still must establish a motivation to assure that value gets adequate consideration along with all the other things that compete for a designer's time—such as schedule, weight, stress, reliability, quality, and maintainability. This suggests that a value goal or budget must be established. A dollar figure would be established for each major component of the product. This dollar figure would be the total "budget" for that component, including design, testing, tooling, planning, and manufacturing—the total cost to design, build, and deliver. The budget would naturally be rigid but realistic, so that proposed designs are re-examined to assure that the most valuable alternates in design, tooling and material and manufacturing are chosen. It would require that the designer call in the production people, the tooling people, the quality people and the procurement people—all those functions which can contribute towards an over-all decision. There are producibility problems, procurement problems, and quality problems as complex and as difficult to resolve as the problems faced by the designer when he must overcome space, heat, and environment. There must be a closing of the ranks between engineering, tooling, procurement, and manufacturing with industrial engineering as the catalyst. And the ranks must be closed very tight—the ranks must be closed "before-the-fact."

From a paper entitled "Industrial Engineering Before the Act" presented at the National Aeronautic Meeting of the Society of Automotive Engineers, New York, April 1961.

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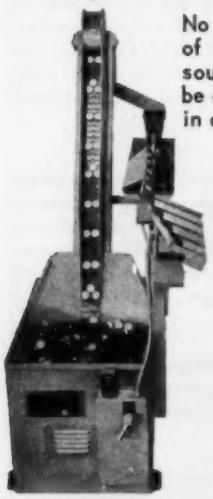

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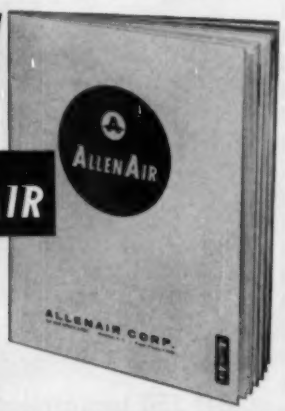

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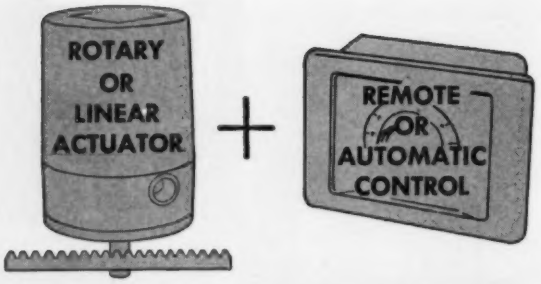

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PROGRAMMING PUNCH PRESSES **Case 2507-P**

. . . We are considering piercing a large number of ⅜ to 1-inch diameter holes on various centerlines in the web and flanges of ¼ inch steel channel, 10 inches wide with 3-inch flanges, and 30 feet long. Annual requirements are quite high, and the hole patterns vary. We wish to pierce in a punch press that will be numerically programmed with punched tape. A left and righthand channel will be fed into the press with flanges facing downward, and the web holes will be punched simultaneously (one hole in a left and one hole in a right). There will be a separate set of punches and die buttons for the web holes in the left and right channels, and the flange holes will be independently pierced by hydraulic units. Our problem is how to actuate and align the two punch and die blocks for the web holes. . . . **Planning Engineer**

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Case 2428-P (Sept. 1961) **ELECTRICAL LEVEL INDICATOR**

. . . If plus or minus one-half degree is satisfactory, he can use a device such as the SMT20 tilt-sensitive mercury switch, manufactured by Hamlin Inc. A pair of these switches mounted at right angles would determine a level plane for him. If he intends to establish a horizontal plane by automatic means, he might do well to sense not only which way, but also how far, his plane is off-level. For this purpose, the same company makes a gravity-sensing electrolytic potentiometer, type EP1012. In conjunction with suitable circuitry, this device could drive indicating meters or serve as the input transducer for an automatic leveling system . . . **C. H. Chandler, Gillette Safety Razor Co.**

Case 2503-P (Oct. 1961) **DETECTING BREAKS**

. . . The enclosed sketches are possible methods of detecting wire or thread breaks. The drawings are purely indicative of the ideas and not drawn to scale. If the packaging engineer has any further questions concerning these solutions, I will be pleased to answer any questions I can . . . **Clarke K. Wolfert.**

. . . If you will refer the packaging engineer to us and request that he send samples of both the thread and the wire, we believe we can solve his problem electronically . . . **L. F. Roletter, General Electric Co.**

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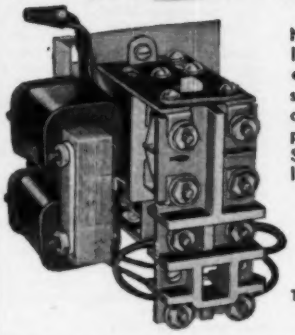

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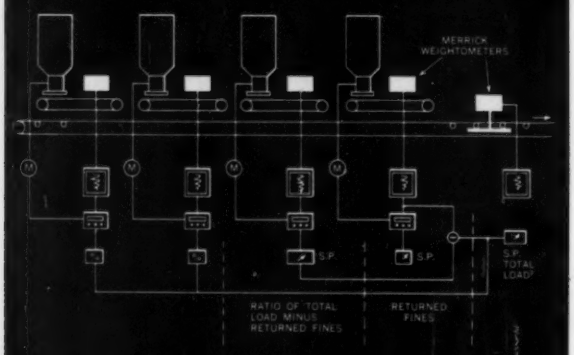

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MECHANICAL MEASUREMENTS

By T. G. Beckwith, professor of mechanical engineering and N. L. Buck, professor and head of mechanical engineering, both of University of Pittsburgh; 559 pages, 6 by 9 inches, published by Addison-Wesley Publishing Co. Inc., Reading, Mass.; available from AUTOMATION; *$8.75 postpaid.*

The subject of this book applies to a diverse list of physical quantities including linear and angular displacement, time intervals, stress and strain, acceleration, dimensional measurements, vibration, pressure, and temperature. The authors have addressed the book primarily to mechanical engineers. Reflecting the subject's increasing importance, dynamic measurement as opposed to static measurement is stressed.

THE ENCYCLOPEDIA OF SPECTROSCOPY

Edited by George L. Clark, research professor of analytical chemistry, emeritus, University of Illinois; 787 pages, 7 by 10 inches, published by Reinhold Publishing Corp., New York; available from AUTOMATION; *$25.00 postpaid.*

Over 160 experts contributed especially prepared articles which, in total, form an authoritative survey of the entire field of spectroscopy. In addition to the traditional fields of applications, such as chemistry, physics, metallurgy, etc., this work also considers the industrial applications of spectroscopy in research, testing, and on-stream control in plants.

STATISTICAL ANALYSIS AND OPTIMIZATION OF SYSTEMS

By E. L. Peterson, member of professional staff, Technical Military Planning Operation, General Electric Co.; 190 pages, 5¾ by 9 inches, published by John Wiley & Sons Inc., New York; available from AUTOMATION; *$9.75 postpaid.*

The purpose of this book is to provide a convenient reference to some of the more important aspects to the statistical analysis and optimization of linear systems. Proceeding in a logical manner, the author discusses linear system theory, statistics of random variables, etc., in laying the groundwork for more complex topics such as multidimensional, nonlinear boundary-valued variational problems in optimal synthesis.

AUTOMATION IN THE OFFICE

By Ida R. Hoos; 138 pages, 5¾ by 9 inches, published by Public Affairs Press, Washington, D. C.; available from AUTOMATION; *$4.50 postpaid.*

This non-technical book concerns itself primarily with the short run effects of "automation" on the clerical labor force. In addition to the usual references in this area, the author has drawn upon the results of personal interviews with executives, union leaders, and government officials in preparing this work.

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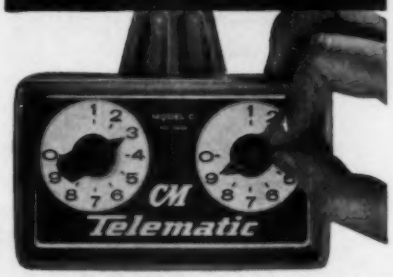

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Quality metal products deserve "the finishing touch" of Mahon

another example: Tappan's new dishwasher and famous '400 RANGE SERIES' of appliances now finished in unique COMBINATION system

For any product finishing, *"Mahon designs equipment but engineers results"*. The recently installed Mahon finishing system for Tappan fully attests to the statement. Here's equipment designed to improve quality, provide painting versatility, expand capacity, reduce material inventories and slash finishing costs. Mahon, working with Tappan plant engineers, supplied the answer—an integrated finishing system to do washing, phosphatizing, dip painting, spray painting, plasticol coating and oven baking of about 300 different parts. Floor space? It *saves* 4000 sq. ft. of production area as it has now been relocated on the plant roof. Results? A versatile, efficient system that met all requirements *and* is now saving Tappan $60,000 a year. Can you afford not to call in Mahon on your metal cleaning and industrial finishing problems?

The Tappen Co. of Mansfield, Ohio, a quality leader in the home-range field has now expanded into the dishwasher market with advanced-design, big-capacity models... finished by Mahon.

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Steel Fabrication—weldments, machining and assembly • Structural Steel—fabrication and erection • Rolling Steel Doors—standard, Labeled and power-operated

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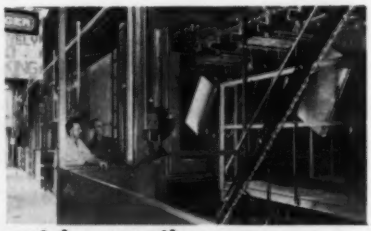
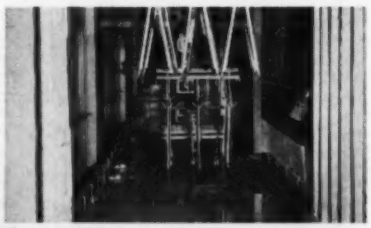
ALSO IN SWEETS P. E. FILE.

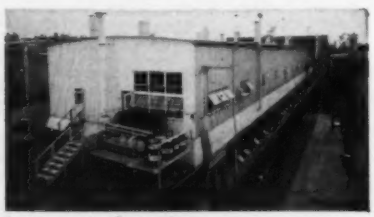


metal preparation, cleaning and phosphatizing is done in a seven-stage Mahon automatic-cycle unit.



dip coating or spray painting in same unit—dip tank is on tracks and automatically positioned.

plasticol coating is by high-pressure spray in Mahon water-wash booths with reclamation pans.



integrated system is self-housed on plant roof—made change-over easy, saved space.

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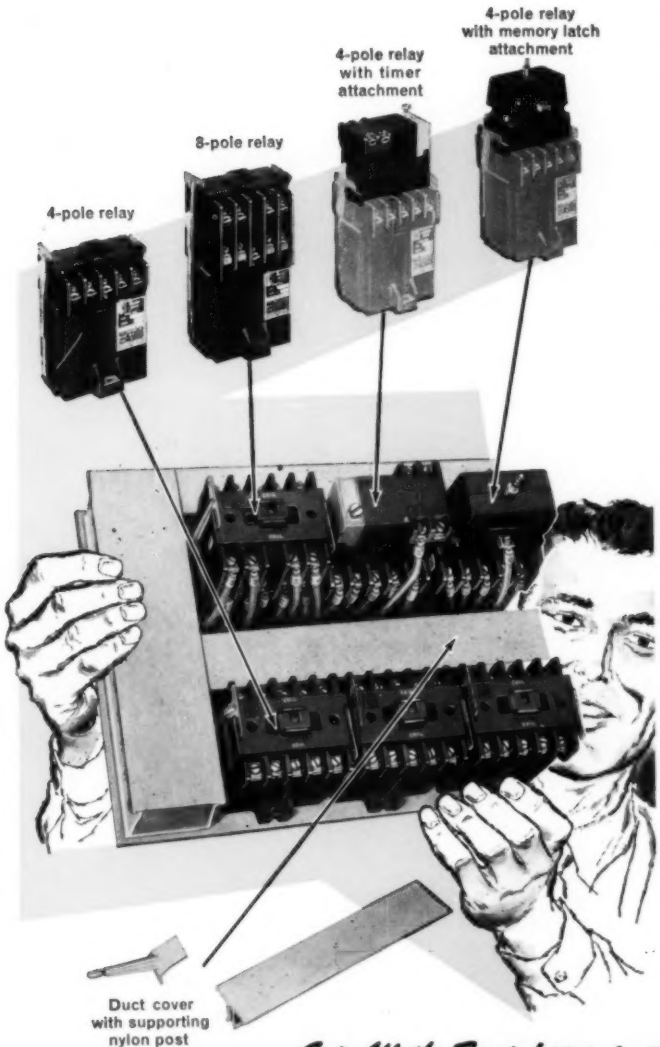
NEW
Square D 300-volt Control System
for Outstanding Versatility, Drastically Reduced Panel Space!


4-pole relay with memory latch attachment
4-pole relay with timer attachment
8-pole relay
4-pole relay
Duct cover with supporting nylon post

Here's the most advanced, easiest-to-use control system ever built! Just two basic relays plus two attachments (latching mechanism and timer) fill all your requirements. Square D's new **Type G 10-ampere relay** is small—has convertible contacts—can be disassembled in seconds without removing wiring—is manually operable. You get all these advantages with Square D's new 300-volt control system!

Saves panel space • Small relay size plus drastically reduced wiring space requirements mean the most compact panel you can build!

Convertible contacts • Change from normally open to normally closed (or vice versa) without removing a screw, without adding a single part, without touching the stationary contacts or removing any wiring! Just flip over the movable contact with a screwdriver. All contacts double-break, individually convertible for any combination you need.

Makes its own duct • Snap molded nylon posts into ¼-inch holes on panel, snap duct cover on posts—and your duct is complete! All terminals remain out in the open—you can change relays, convert contacts, add timer or latching mechanism without disturbing duct. Because device and duct mounting are independent, relay spacing and alignment are not critical.

Timer and memory latch attachments can be added in just seconds! Simply lift up and slide back the relay latches, remove the cover and slip on the desired attachment. Attachments require no additional panel space! Timer easily changed from on-delay to off-delay, is adjustable from 0.2 second to 1 minute.

Get All the Facts! **Write for Bulletin SM-307 for construction details, dimensions, ordering information—the complete story on the new Square D 300-volt control system. Square D Company, Dept. SA, 4041 North Richards Street, Milwaukee 12, Wisconsin**

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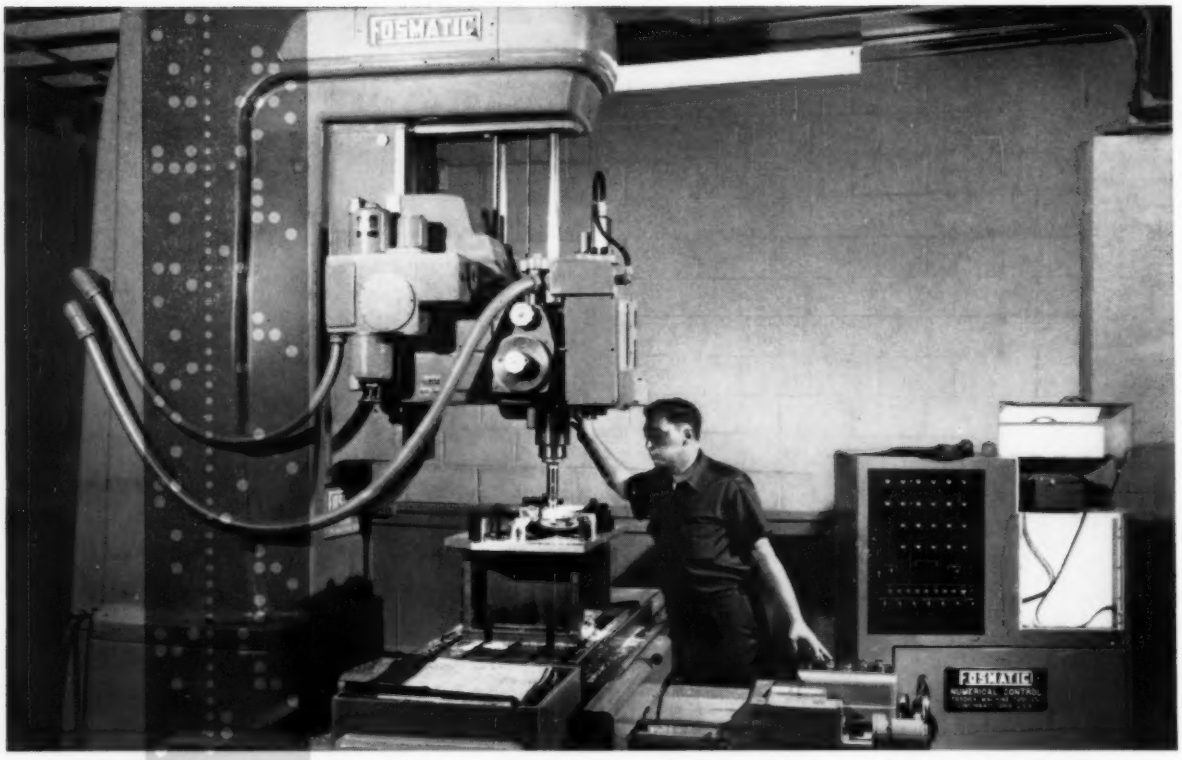

Pioneering in a new style job shop specializing in numerically controlled machining is Numerical Machining Inc. (NuMac). This Cleveland shop keeps the above model 54-p Fosmatic N/C Jig Borer plus three other N/C machines busy with a constant flow of rush work. NuMac grew out of Industrial Enterprises Co., a conventional machine shop drawing most of its business from a 30 mile radius. Now NuMac draws business from 3,000 miles!

Numerical Control Bonanza

Golden opportunity awaits the shop that makes a specialty of numerical control! It's suited to almost any small lot job which can be mathematically described. N/C is a real money saver and a money maker!

You can open this rich vein with a Fosmatic Jig Borer or Numerically Controlled Drill, both directed in all three axes by tape control. You'll realize faster precision boring, drilling, tapping, and milling at the punch of a paper tape. You'll also be able to offer lead time cut by weeks, engineering changes implemented in hours, tooling costs cut by thousands to justify your investment.

Take a tip from fast-growing Nu-Mac of Cleveland and be the first shop in your territory to tap the mother lode of numerical control. Write today for Fosmatic bulletins PBM-P (N/C Jig Borers) and TD-P (N/C Drills). Better yet, "get a proposal from Fosdick!"

FOSDICK

The Fosdick Machine Tool Company, Cincinnati 23, Ohio

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